



2N104

2N104

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For small-signal audio-frequency applications

GENERAL DATA

Electrical:

Minimum DC Collector-to-Base Voltage for dc collector current of $-20 \mu\text{amp}$ with emitter open, and at ambient temperature of 25°C	-30	volts
Maximum DC Collector Current for dc collector-to-base voltage of -12 volts with emitter open, and at ambient temperature of 25°C	-10	μamp
Maximum DC Emitter Current for dc emitter-to-base voltage of -12 volts with collector open, and at ambient temperature of 25°C	-10	μamp
Junction Temperature Rise (In free air)	0.4	$^\circ\text{C}/\text{mw}$

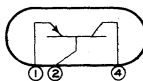
Mechanical:

Mounting Position	Any
Maximum Overall Length	$0.697''$
Maximum Seated Length	$0.495''$
Maximum Diameter	$0.260''$
Dimensional Outline	See front of this Section
Case	Metal, Insulated
Envelope Seals	Hermetic
Base	Small-Round Linotetrar 3-Pin (JETEC No. E3-25)

Pin 1 - Emitter

Pin 4 - Collector

Pin 2 - Base



AUDIO-FREQUENCY AMPLIFIER -- Class A

Maximum Ratings, Absolute Values:

DC COLLECTOR-TO-BASE VOLTAGE	-30 max.	volts
DC COLLECTOR CURRENT	-50 max.	ma
DC EMITTER CURRENT	50 max.	ma
TRANSISTOR DISSIPATION	See Rating Chart	
AMBIENT TEMPERATURE (During operation)	70 max.	$^\circ\text{C}$
STORAGE-TEMPERATURE RANGE	-55 to $+85$	$^\circ\text{C}$

Characteristics, At Ambient Temperature of 25°C :

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage	-4	-6	volts
DC Collector Current	-0.7	-1	ma
Power Gain:			
With load resistance = $20,000$ ohms, and input resistance = 1400 ohms.	$-$	41	db

2N104



2N104

JUNCTION TRANSISTOR

Noise Factor:

Measured with a noise diode and thermocouple voltmeter with load resistance = 20,000 ohms, generator resistance = 518 ohms, and equivalent noise bandwidth = 12.3 kc with geometric mean of 300 cps

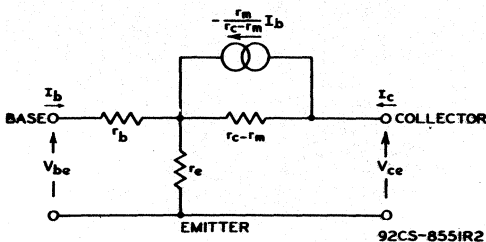
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db

Small-Signal T Parameters:

Derived from the accompanying one-generator equivalent circuit, and applicable to that portion of the audio-frequency range in which internal capacitance effects may be neglected

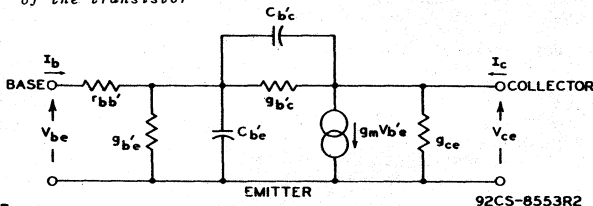


For conditions where $-r_m / (r_c - r_m) \approx -(r_m + r_e) / (r_c - r_m + r_e) = \alpha_f$:

DC Collector-to-Emitter Voltage (V_{CE})	-3	-6	volts
DC Collector Current (I_C)	-0.2	-1	ma
Emitter Resistance (r_e)	155	21.7	ohms
Base Resistance (r_b)	960	690	ohms
Mutual Resistance (r_m)	2.86	1.93	megohms
Collector Resistance (r_c)	2.95	1.974	megohms
Current Transfer Ratio (α_f) [■]	-32	-44	

Small-Signal Hybrid- π Parameters:

Derived from the accompanying one-generator equivalent circuit, and applicable over the useful frequency range of the transistor



■ Measured at 1 kc.



2N104

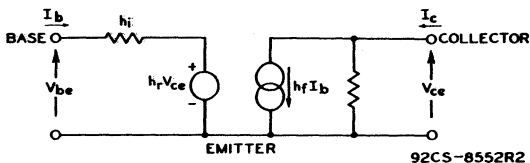
2N104

JUNCTION TRANSISTOR

DC Collector-to-Emitter Voltage (V_{CE})	-3	-6	volts
DC Collector Current (I_C)	-0.2	-1	ma
Resistance $r_{bb'}$	300	290	ohms
Conductance $g_{b'e}$	174	727	μ hos
Conductance g_{ce}	1.28	6.62	μ hos
Conductance $g_{b'c}$	0.3	0.36	μ ho
Capacitance $C_{b'e}$	1225	6900	μ f
Capacitance $C_{b'c}$	36	40	μ f
Intrinsic Transconductance (g_m)	5540	32000	μ hos
Frequency* for unity power amplification	1.6	1.6	Mc

Small-Signal H Parameters:

Derived from accompanying two-generator equivalent circuit,
and applicable to that portion of the audio-frequency range
in which internal capacitance effects may be neglected



DC Collector-to-Emitter Voltage (V_{CE})	-3	-6	volts
DC Collector Current (I_C)	-0.2	-1	ma
Input Resistance, output circuit shorted (h_i)	6040	1667	ohms
Reverse Voltage Transfer Ratio, input circuit open (h_r)	17.2×10^{-4}	4.95×10^{-4}	
Forward Current Transfer Ratio, output circuit shorted (h_f)	32	44	
Output Conductance, input circuit open (h_o)	11.1	22.8	μ hos

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-3	-6	volts
DC Collector Current	-0.2	-1	ma
Power Gain:			
With load resistance = 0.5 megohm, and input resistance = 170 ohms.	-	32.4	db
Frequency at which the current transfer ratio drops to one-half the square root of two times its value at 1 kc	530	700	kc

* See next page.

6-56

SEMICONDUCTOR DIVISION

RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

TENTATIVE DATA 2



2N104

JUNCTION TRANSISTOR

Common-Collector Circuit, Base Input

DC Emitter-to-Collector Voltage. 3 volts
 DC Emitter Current 0.2 ma

Power Gain:

With load resistance = 18,000 ohms,
 and input resistance = 0.5 megohm. . . . 14.3 db

- This frequency (figure of merit) may be calculated from the equation

$$f = \frac{1}{4\pi} \sqrt{\frac{g_m}{r_{bb} \cdot C_b \cdot C_e}}$$

OPERATING CONSIDERATIONS

The 2N104 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

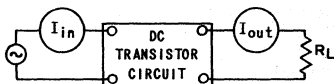
TRANSISTOR DISSIPATION RATING CHART

The Transistor Dissipation Rating Chart may be used to determine, for a particular circuit application, the maximum allowable transistor dissipation. On this chart, solid boundary lines ABC, DEF, and GHI are the loci of the maximum allowable dissipation for operating ambient temperatures of 25°C, 50°C, and 70°C, respectively. The dashed curves for the various values of circuit stability factor represent conditions where the maximum allowable dissipation is current limited by the maximum dc collector current rating of -50 milliamperes.

It is recommended that the 50°C-ambient-temperature curve be used in commercial applications, and the 70°C curve for industrial applications. The 25°C curve should not be used unless the equipment is operated under closely controlled ambient-temperature conditions.

To use this chart it is only necessary to know the dc collector-to-emitter voltage, dc collector current, ambient temperature after equipment warm-up, and the circuit stability factor, S_F .

The circuit stability factor is equal to the dc-circuit current gain of the transistor (between collector and base) plus one. It may be measured empirically from the arrangement shown at left. If a



where I_{in} = input current
 I_{out} = output current
 and R_L = load resistance

current, I_{in} , of 1 micro-ampere dc is passed through the transistor circuit, the value of I_{out} in microamperes measured plus one is equal to the circuit stability factor.



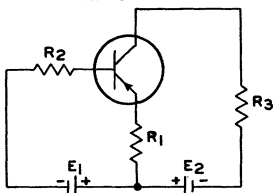
2N104

2N104

JUNCTION TRANSISTOR

For conditions where the base spreading resistance, r_{bb} , is much less than the external emitter- or base-circuit resistance, and where the forward current transfer ratio, α_f , is much greater than 1, the circuit stability factor may also be calculated for three commonly-used dc circuit configurations from the formulas below:

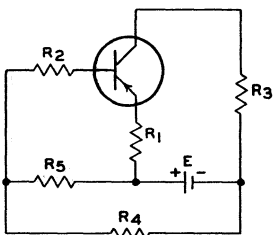
CIRCUIT A



$$S_F = \frac{|\alpha_f|(R_1 + R_2)}{R_2 + |\alpha_f|R_1}$$

Two-battery-operated stage

CIRCUIT B



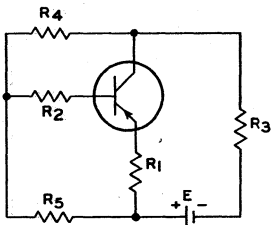
$$S_F = \frac{|\alpha_f|(R_1 + R_{eq})}{R_{eq} + |\alpha_f|R_1}$$

where

$$R_{eq} = R_2 + \frac{R_4 R_5}{R_4 + R_5}$$

Single-battery-operated stage

CIRCUIT C



$$S_F = \frac{|\alpha_f|(P + Q)}{Q + |\alpha_f|P}$$

where

$$P = R_1(R_3 + R_4 + R_5) + R_3 R_5$$

$$Q = R_2(R_3 + R_4 + R_5) + R_4 R_5$$

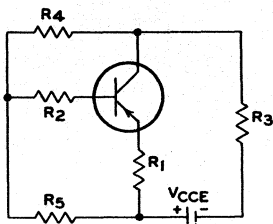
Single-battery-operated stage
with degenerative feedback



2N104

JUNCTION TRANSISTOR

For example, in the following dc equivalent circuit for a typical commercial application employing common-emitter circuit, base input, it is desired to determine if the transistor will be operating within dissipation rating if the dc collector-to-emitter voltage is -6 volts, the dc collector current is -1 milliampere, and the ambient temperature after equipment warm-up is 50°C. Under these conditions, the transistor dissipation is approximately equal to the collector dissipation $V_{CE} \times I_C$, or 6 milliwatts.



Circuit components:

- $R_1 = 270 \text{ ohms}$
- $R_2 = 1000 \text{ ohms}$
- $R_3 = 9000 \text{ ohms}$
- $R_4 = 43000 \text{ ohms}$
- $R_5 = 3900 \text{ ohms}$

- (1) By use of the curve showing the variation of the forward current transfer ratio, α_f , with ambient temperature, for an ambient temperature of 50°C, a value of α_f equal to -56 is obtained.
- (2) Using formulas shown for circuit C,

$$P = 270(9000 + 43000 + 3900) + (9000)(3900)$$

$$P = 5.02 \times 10^7 \text{ ohms}^2$$

$$Q = 1000(9000 + 43000 + 3900) + (43000)(3900)$$

$$Q = 22.4 \times 10^7 \text{ ohms}^2$$

$$S_F = \frac{56 [(5.02 \times 10^7) + (22.4 \times 10^7)]}{(22.4 \times 10^7) + 56 (5.02 \times 10^7)}$$

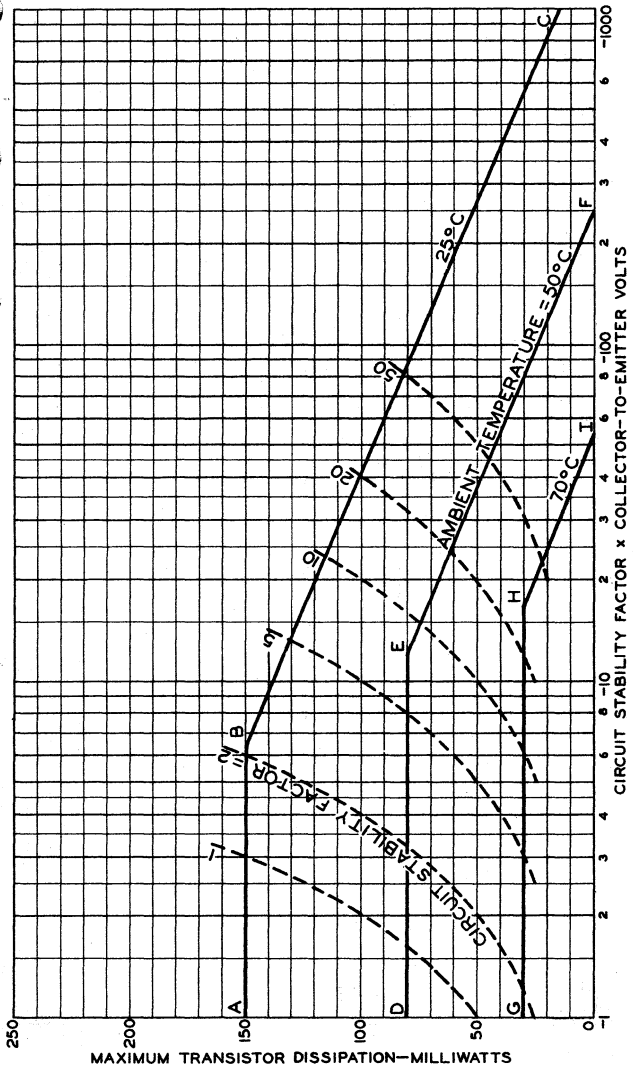
$$S_F = 5.06$$
- (3) Referring to the dissipation chart, for an abscissa ($S_F \times V_{CE} = 5.06 \times -6$) of -30.4 and an ambient temperature of 50°C, the maximum dissipation rating is 55 milliwatts. Since the actual transistor dissipation of 6 milliwatts is well within the maximum dissipation, the transistor is being operated with a considerable degree of safety.



2N104

2N104

TRANSISTOR DISSIPATION RATING CHART



MAXIMUM TRANSISTOR DISSIPATION—MILLIWATTS

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92CM-8530R1

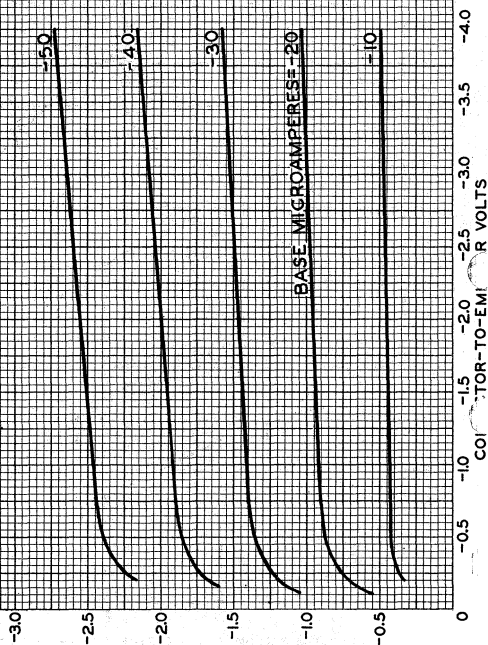
2N104



2N104

AVERAGE COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT
AMBIENT TEMPERATURE = 25°C



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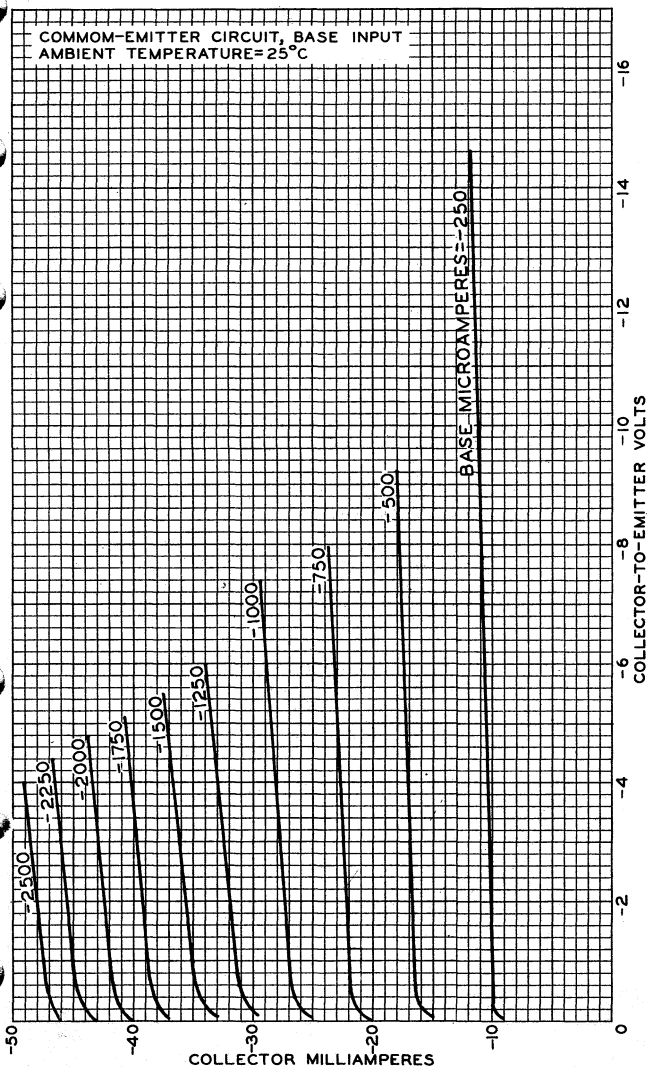
92CM-8524RI



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AVERAGE COLLECTOR CHARACTERISTICS



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92CM-8512RI

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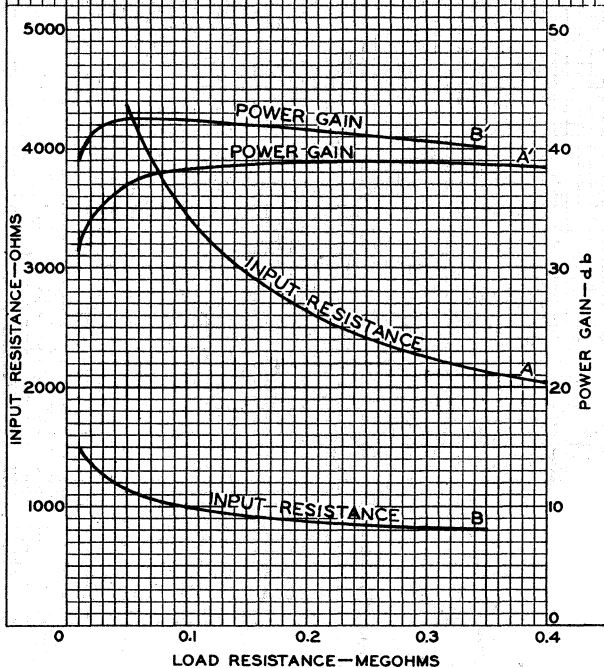


2N104

OPERATION CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT
 AMBIENT TEMPERATURE=25°C

CURVE	COLLECTOR-TO-EMITTER VOLTS	COLLECTOR MA
A & A'	-3	-0.2
B & B'	-6	-1



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92CM-8518R2



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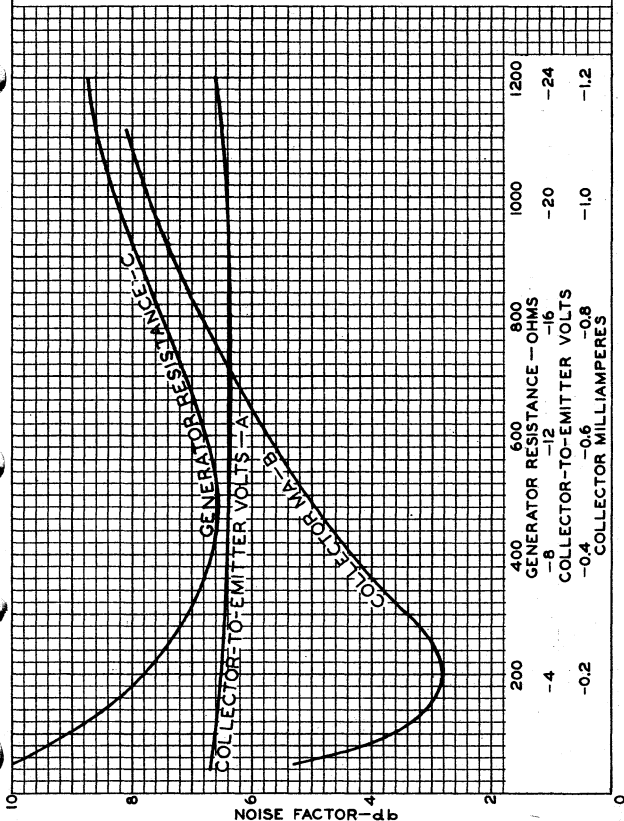
TYPICAL NOISE CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT

AMBIENT TEMPERATURE=25°C

MEASURED WITH A NOISE DIODE AND THERMOCOUPLE VOLT-METER WITH LOAD RESISTANCE=20000 OHMS AND EQUIVALENT NOISE BANDWIDTH=12.3KC WITH GEOMETRIC MEAN OF 300 CPS

CURVE	GENERATOR RESISTANCE (OHMS)	COLLECTOR-TO-EMITTER VOLTS	COLLECTOR MA
A	518	—	-0.7
B	518	-4	—
C	—	-4	-0.7



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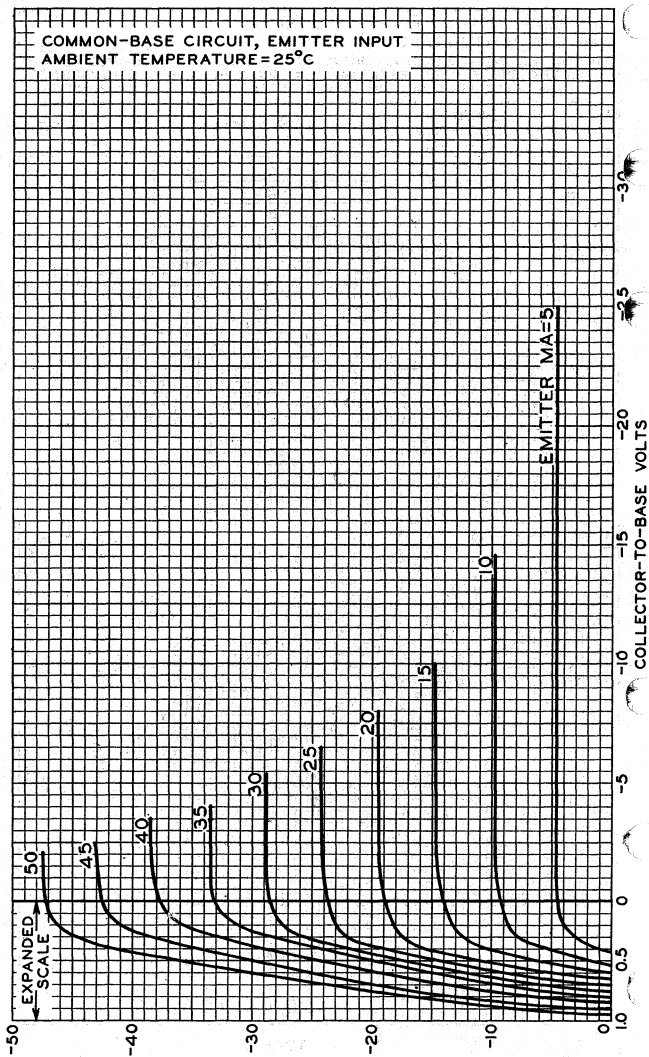
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AVERAGE COLLECTOR CHARACTERISTICS



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92CM-8515RI



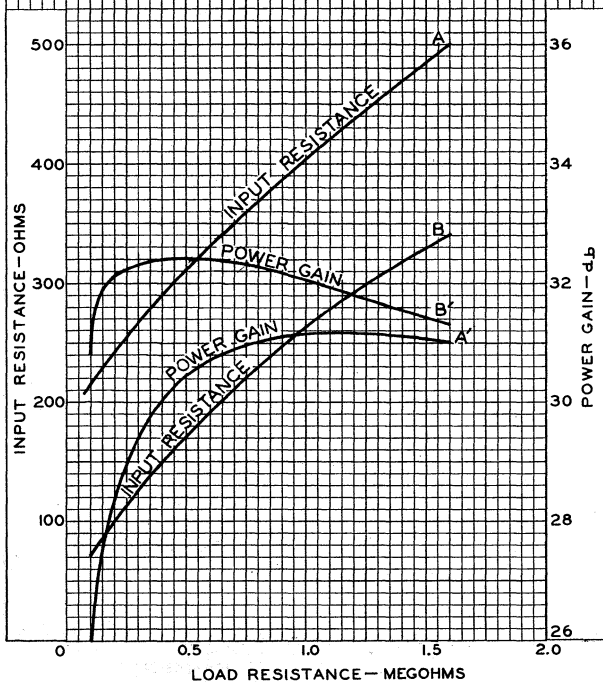
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OPERATION CHARACTERISTICS

COMMON-BASE CIRCUIT, EMITTER INPUT
AMBIENT TEMPERATURE=25°C

CURVE	COLLECTOR-TO-BASE VOLTS	COLLECTOR MA
A & A'	-3	-0.2
B & B'	-6	-1

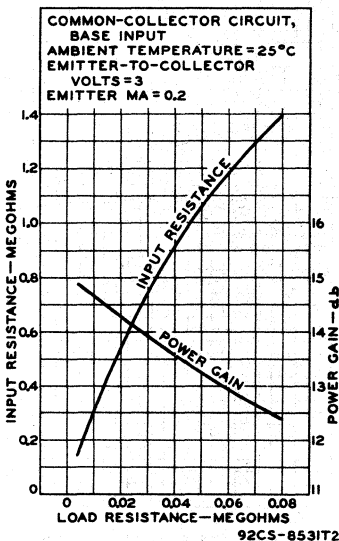
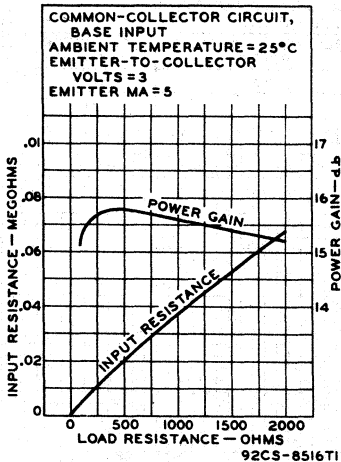
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OPERATION CHARACTERISTICS



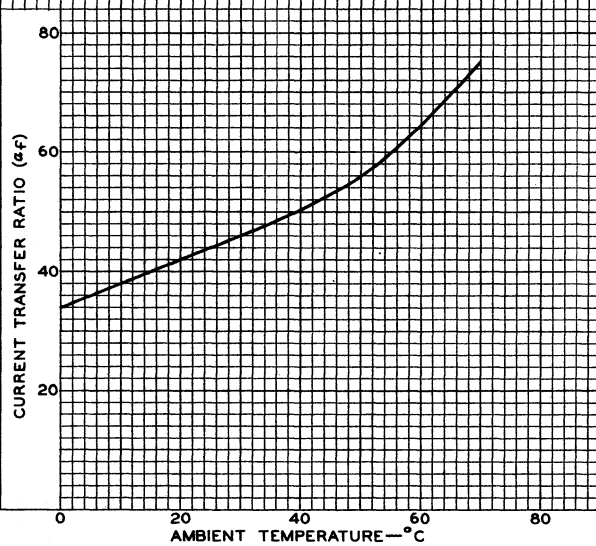


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AVERAGE CHARACTERISTIC

COMMON-EMITTER CIRCUIT, BASE INPUT
COLLECTOR-TO-EMITTER VOLTS = -6
COLLECTOR MA = -1

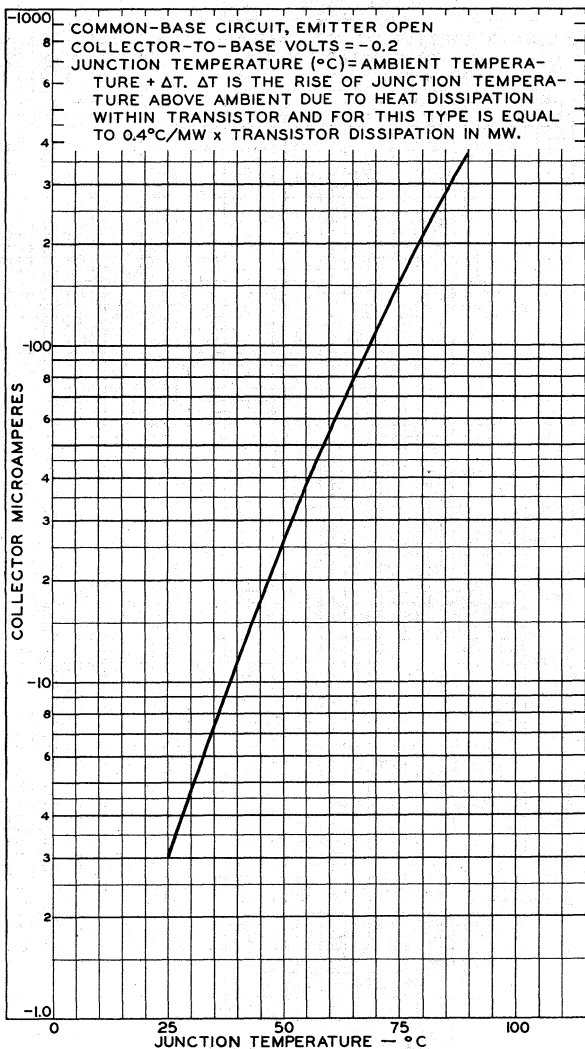


2N104



2N104

OPERATION CHARACTERISTIC



Transistor

GERMANIUM P-N-P ALLOY TYPE

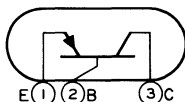
For Low-Power, Small-Signal and Large-Signal
Audio Applications in Consumer-Product Equipment

Mechanical:

Dimensions See Outline TO-40 in General Section

Terminal Diagram: **BOTTOM VIEW**

Pin 1 - Emitter
Pin 2 - Base



Pin 3 - Collector

Maximum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage . . V_{CBO} -35 max. volts
With emitter open

Collector-to-Emitter Voltage V_{CEO} -25 max. volts
With base open

Emitter-to-Base Voltage . . V_{EBO} -12 max. volts
With collector open

Collector Current I_C -150 max. ma

Transistor Dissipation

At free-air temperatures

From -65° to 25° C P_T 165 max. mw
Above 25° C Derate linearly 2.75 mw/ $^{\circ}$ C

Temperature

Operating range (Junction) T_{opr} -65 to 85 $^{\circ}$ C

Storage range T_{stg} -65 to 85 $^{\circ}$ C

Pins^a (During soldering)

For 10 seconds maximum . . T_P 255 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Free-air temperature = 25° C

Min. Max.

DC Collector-to-Base Break-down Voltage BV_{CBO} -35 - volts
 $I_C = -50 \mu a$, $I_E = 0$

DC Collector-to-Emitter Break-down Voltage BV_{CEO} -25 - volts
 $I_C = -1 \text{ ma.}$, $I_B = 0$

DC Emitter-to-Base Break-down Voltage BV_{EBO} -12 - volts
 $I_E = -7 \mu a$, $I_C = 0$

DC Collector-to-Emitter Saturation Voltage $V_{CE(sat)}$ - -0.15 volts
 $I_C = -50 \text{ ma.}$, $I_B = -5 \text{ ma.}$

← Indicates a change.



2N109

Min. Max.

DC Base-to-Emitter			
Voltage.	V_{BE}	0.2	0.4 volt
$V_{CE} = -1$ volt, $I_C = -50$ ma.			
DC Collector-Cutoff			
Current.	I_{CBO}	-	-7 μ a
$V_{CB} = -30$ volts, $I_E = 0$			
DC Emitter-Cutoff Current. . . I_{EBO}			
$V_{EB} = -12$ volts, $I_C = 0$			
Input Impedance. h_{ie}			
$f = 1$ kc, $V_{CE} = -6$ volts,			
$I_E = -1$ ma.			
Output Capacitance. C_{ob}			
$f = 0.5$ Mc, $V_{CB} = -6$ volts,			
$I_E = -1$ ma.			
DC Forward-Current Transfer			
Ratio.	h_{FE}	65	115
$V_{CE} = -1$ volt, $I_C = -50$ ma.			
Small-Signal Short-Circuit			
Forward-Current Transfer			
Ratio.	h_{fe}	50	150
$f = 1$ kc, $V_{CE} = -6$ volts,			
$I_E = -1$ ma.			

TYPICAL OPERATION

In Class B Push-Pull Audio-Frequency Power Amplifier Circuit

Free-air temperature = 25° C. Unless otherwise specified, values are for two transistors.

DC Collector-To-Emitter			
Supply Voltage	-4.5	-9	volts
DC Base-to-Emitter Voltage . . -0.15			
Peak Collector Current			
(Per transistor)	-35	-40	ma
Zero-Signal DC Collector			
Current (Per transistor) . .	-2	-2	ma
Maximum Signal DC Collector			
Current (Per transistor) . .	-11.5	-13	ma
Signal-Source Impedance			
(Base to base)	1500	1500	ohms
Load Impedance (Collector to			
collector)	400	800	ohms
Signal Frequency	1	1	kc
Circuit Efficiency	60	69	%
Power Gain	30	33	db
Total Harmonic Distortion. . .	10 max.	10 max.	%
Maximum Signal Power Output. .	75	160	mw

^a Measured along pin at distances not less than 1/32" from seating plane.

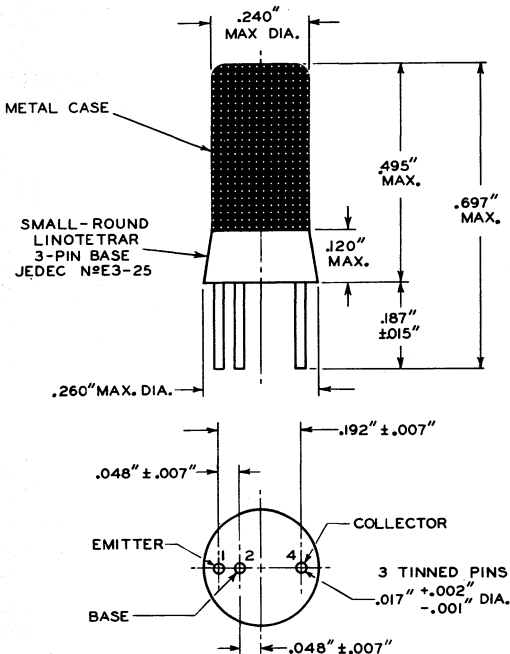




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2N109

JUNCTION TRANSISTOR



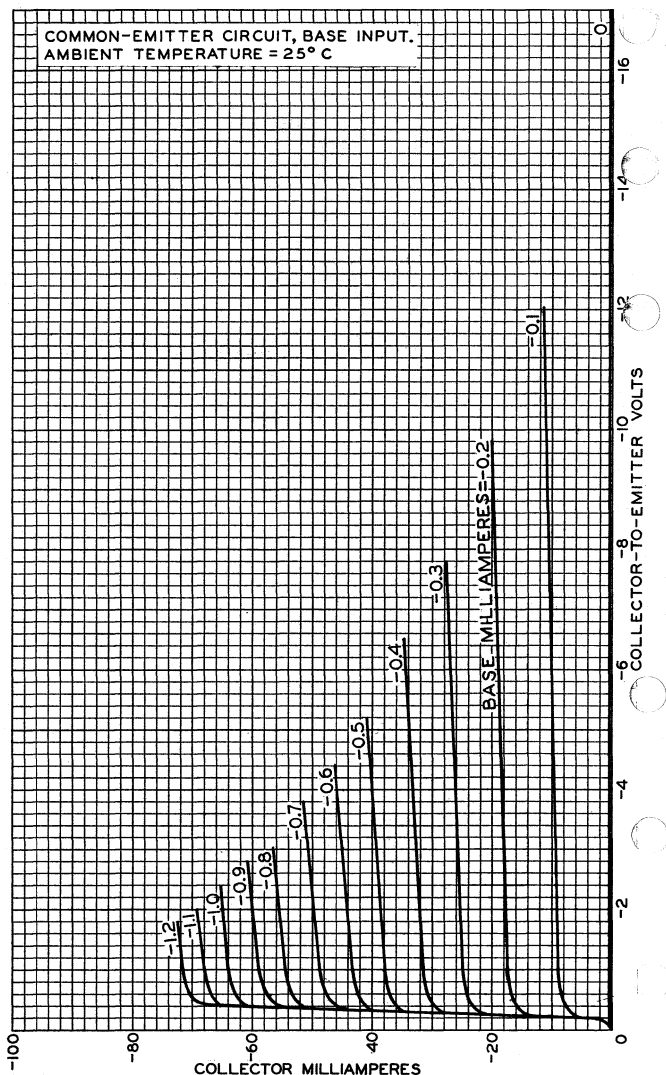
PIN-SPACING TOLERANCES ARE NOT CUMULATIVE
92CS-8550R4

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AVERAGE COLLECTOR CHARACTERISTICS



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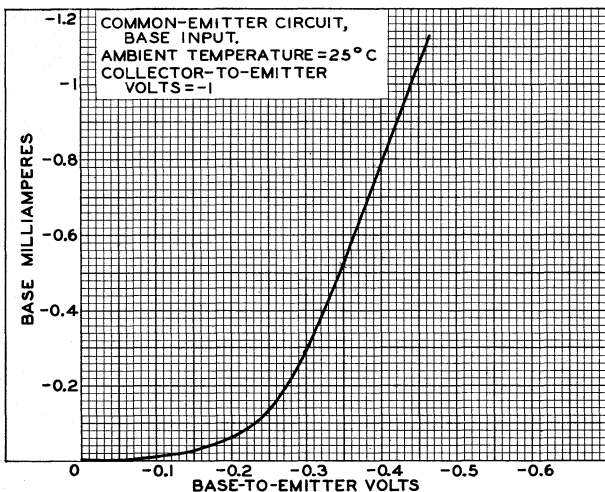
92CM-8599R2



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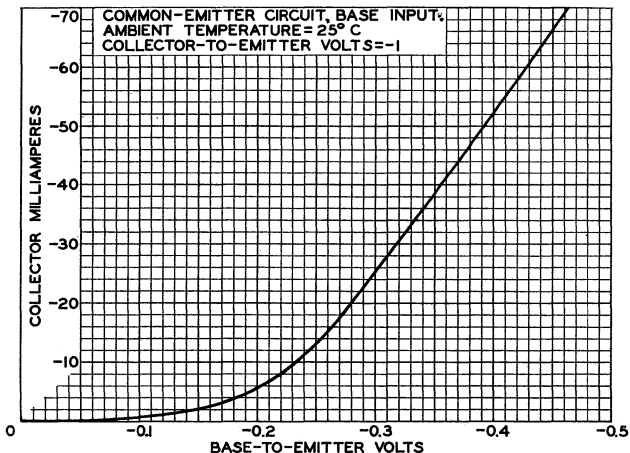
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AVERAGE BASE CHARACTERISTIC



92CS-8602R2

AVERAGE CHARACTERISTIC



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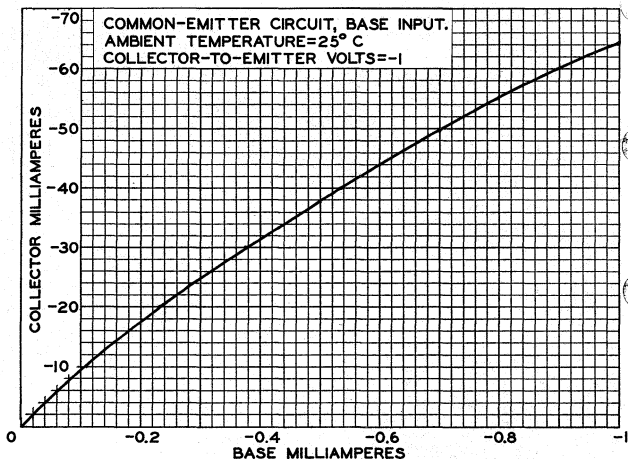
92CS-8598R2

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AVERAGE CHARACTERISTIC



92CS-8600R2



2N139

2N139

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

*For 455-kc intermediate-frequency applications***GENERAL DATA****Electrical:**

Minimum DC Collector-to-Base Voltage for dc collector current of $-10 \mu\text{amp}$ with emitter open, and at am- bient temperature of 25°C	-16	volts
Maximum DC Collector Current for dc collector-to-base voltage of -12 volts with emitter open, and at ambient temperature of 25°C	-6	μamp
Maximum DC Emitter Current for dc emitter-to-base voltage of -12 volts with collector open, and at ambient temperature of 25°C	-40	μamp

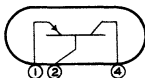
Mechanical:

Mounting Position	Any
Maximum Overall Length	0.697"
Maximum Seated Length	0.495"
Maximum Diameter	0.260"
Dimensional Outline	See front of this Section
Case	Metal, Insulated
Envelope Seals	Hermetic
Base	Small-Round Linotetrar 3-Pin (JETEC No. E3-25)

Pin 1 - Emitter

Pin 4 - Collector

Pin 2 - Base

**INTERMEDIATE-FREQUENCY AMPLIFIER SERVICE****Maximum Ratings, Absolute Values:**

DC COLLECTOR-TO-BASE VOLTAGE	-16 max.	volts
DC EMITTER-TO-BASE VOLTAGE	-12 max.	volts
DC COLLECTOR CURRENT	-15 max.	ma
DC EMITTER CURRENT	15 max.	ma
COLLECTOR DISSIPATION	35 max.	mw
AMBIENT TEMPERATURE (During operation)	70 max.	$^{\circ}\text{C}$
STORAGE-TEMPERATURE RANGE	-55 to +85	$^{\circ}\text{C}$

Characteristics, At Ambient Temperature of 25°C :*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage	-9	-9	volts
DC Collector Current	-0.5	-1	ma
Current Transfer Ratio (α_f)	-45	-48	

■: See next page.

6-56

SEMICONDUCTOR DIVISION

RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

TENTATIVE DATA



2N139

JUNCTION TRANSISTOR

Small-Signal Hybrid- π Parameters:*

DC Collector-to-Emitter Voltage (V_{CE})	-9	-9	volts
DC Collector Current (I_C)	-0.5	-1	ma
Resistance $r_{bb'}$	85	75	ohms
Conductance $g_{b'e}$	425	800	μ mhos
Conductance g_{ce}	4.6	8.6	μ mhos
Conductance $g_{b'c}$	0.22	0.25	μ mhos
Capacitance $C_{b'e}$	900	1560	μ mf
Capacitance $C_{b'c}$	9.5	9.5	μ mf
Intrinsic Transconductance (g_m)	19300	38600	μ mhos
Frequency [•] for unity power amplification	13	14	Mc

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-9	-9	volts
DC Collector Current	-0.5	-1	ma
Current Transfer Ratio [■]	0.978	0.980	
Frequency at which the current transfer ratio drops to one-half the square root of two times its value at 1 kc.	4.5	4.7	Mc

Typical Operation, At Ambient Temperature of 25°C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage	-9	-9	volts
DC Collector Current	-0.5	-1	ma
Input Resistance	1000	500	ohms
Output Resistance	70000	30000	ohms
Spot Noise Factor [▲]	4.5	4.5	db
Maximum Power Gain [§]	38	37	db
Useful Power Gain	27.6 [§]	30.4 [†]	db

* As derived from corresponding equivalent circuit shown under type 2N104.

• This frequency (figure of merit) may be calculated from the equation

$$f = \frac{1}{4\pi} \sqrt{\frac{g_m}{r_{bb'} C_{b'e} C_{b'c}}}$$

■ Measured at 1 kc.

▲ Measured in a single-tuned unilateralized circuit matched to the generator and load impedances for maximum transfer of power. Transformer insertion losses not included. (Unilateralization is a special case of neutralization in which the resistive as well as the reactive feedback parameters are balanced out. Unilateralization changes a bilateral network into a unilateral network).

§ A transformer insertion loss of 10.4 db is included in this figure.

† A transformer insertion loss of 6.6 db is included in the figure.

OPERATING CONSIDERATIONS

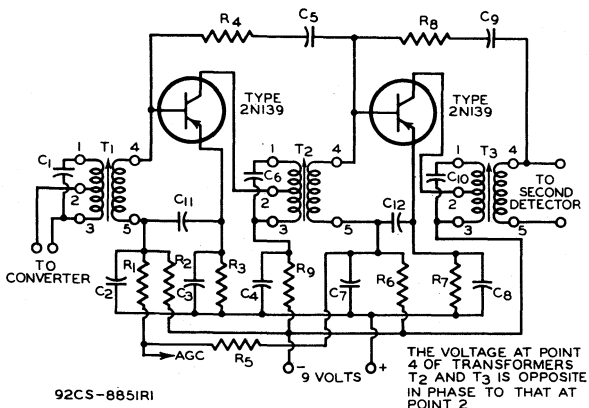
The 2N139 should not be connected into or disconnected from circuits with the power are because high transient currents may cause permanent damage to the transistor.



2N139

2N139

JUNCTION TRANSISTOR

TYPICAL 455-KC INTERMEDIATE-FREQUENCY
AMPLIFIER CIRCUIT

C1 C6 C10: 220 μ f
 C2: 50 μ f
 C3 C4 C8: 0.05 μ f
 C5: 75 μ f
 C7: 25 μ f
 C9: 33 μ f
 C11 C12: 0.1 μ f
 R1: 12000 ohms

R2: 0.15 megohm
 R3 R7: 820 ohms
 R4: 560 ohms
 R5: 18000 ohms
 R6: 0.1 megohm
 R8: 2000 ohms
 R9: 560 ohms

Transformer:

	T1	T2	T3	
Reflected resistance of primary between terminals 2 and 3 with secondary terminated.	206000	29000	10900	ohms
Reflected resistance of secondary with primary terminated.	1000	500	1000	ohms
Turns ratios:				
Terminals 1 and 3 to terminals 2 and 3.	1.17	2.48	3.16	
Terminals 1 and 3 to terminals 4 and 5.	16.8	18.9	10.43	
Terminals 2 and 3 to terminals 4 and 5.	14.35	7.62	3.3	
Core Material.	Ferrite	Ferrite	Ferrite	
Unloaded Q (mounted in chassis).	110	61	110	
Loaded Q (mounted in chassis).	35	35	35	

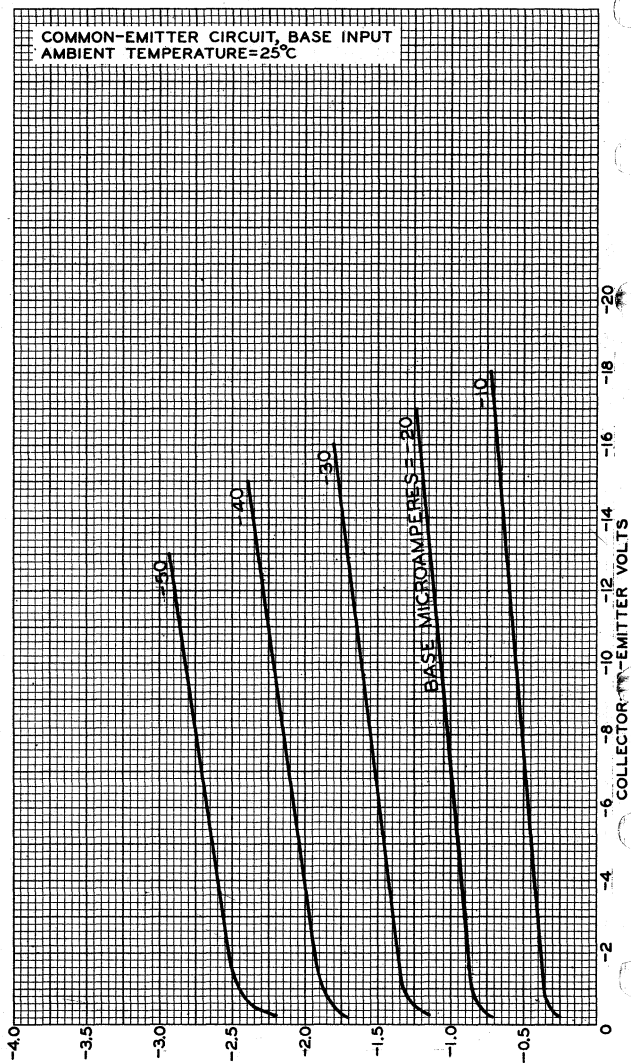
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2N139



2N139

AVERAGE COLLECTOR CHARACTERISTICS



SEMICONDUCTOR DIVISION

RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

92CM-8849RI



2N140

2N140

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For 540 to 1600 kc converter applications

GENERAL DATA

Electrical:

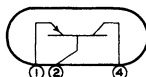
Minimum DC Collector-to-Base Voltage for dc collector current of $-10 \mu\text{amp}$ with emitter open, and at ambient temperature of 25°C	-16	volts
Maximum DC Collector Current for dc collector-to-base voltage of -12 volts with emitter open, and at ambient temperature of 25°C	-6	μamp
Maximum DC Emitter Current for dc emitter-to-base voltage of -12 volts with collector open, and at ambient temperature of 25°C	-40	μamp

Mechanical:

Mounting Position	Any
Maximum Overall Length	0.697"
Maximum Seated Length	0.495"
Maximum Diameter	0.260"
Dimensional Outline	See front of this Section
Case	Metal, Insulated
Envelope Seals	Hermetic
Base	Small-Round Linotetrar 3-Pin (JETEC No. E3-25)

Pin 1 - Emitter

Pin 2 - Base



Pin 4 - Collector

CONVERTER SERVICE

Maximum Ratings, Absolute Values:

DC COLLECTOR-TO-BASE VOLTAGE	-16 max.	volts
DC EMITTER-TO-BASE VOLTAGE	-12 max.	volts
DC COLLECTOR CURRENT	-15 max.	ma
DC EMITTER CURRENT	15 max.	ma
COLLECTOR DISSIPATION	35 max.	mw
AMBIENT TEMPERATURE (During operation)	70 max.	$^{\circ}\text{C}$
STORAGE-TEMPERATURE RANGE	-55 to $+85$	$^{\circ}\text{C}$

Characteristics, At Ambient Temperature of 25°C :

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage	-9	volts
DC Collector Current	-0.6	ma
Current Transfer Ratio (α_f) [■]	-48	

■: See next page.



2N140

JUNCTION TRANSISTOR

Small-Signal Hybrid- π Parameters:*

DC Collector-to-Emitter Voltage (V_{CE})	-9	volts
DC Collector Current (I_C)	-0.6	ma
Resistance $r_{bb'}$	85	ohms
Conductance $g_{b'e}$	480	μ hos
Conductance g_{ce}	5.4	μ hos
Conductance $g_{b'c}$	0.23	μ ho
Capacitance $C_{b'e}$	650	μ uf
Capacitance $C_{b'c}$	9.5	μ uf
Intrinsic Transconductance (g_m)	22600	μ hos
Frequency for unity power amplification	16.5	Mc

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-9	volts
DC Collector Current	-0.6	ma
Current Transfer Ratio [■]	0.980	
Frequency at which the current transfer ratio drops to one-half the square root of two times its value at 1 kc	7	Mc

Typical Operation, At Ambient Temperature of 25°C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage	-9	volts
DC Collector Current	-0.6	ma
Input Resistance	600	ohms
Output Resistance	75000	ohms
RMS Base-to-Emitter Oscillator Injection Voltage	100	mv
Signal Frequency	1	Mc
Useful Conversion Power Gain	30	db

* As derived from corresponding equivalent circuit shown under type 2N104.

■ Measured at 1 kc.

● This frequency (figure of merit) may be calculated from the equation

$$f = \frac{1}{4\pi} \sqrt{\frac{g_m}{r_{bb'} C_{b'c} C_{b'e}}}$$

OPERATING CONSIDERATIONS

The 2N140 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

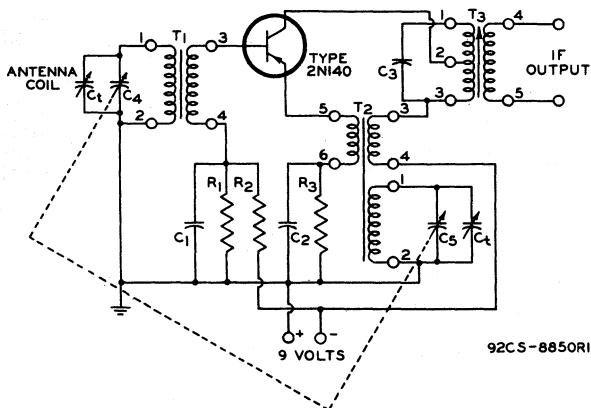


2N140

2N140

JUNCTION TRANSISTOR

TYPICAL SELF-EXCITED CONVERTER CIRCUIT

C1: 0.05 μ fC2: 0.04 μ fC3: 220 μ fC4: 12 to 230 μ f (variable)C5: 10 to 105 μ f (variable) C_t : 2 to 20 μ f (variable)

R1: 6800 ohms

R2: 18000 ohms

R3: 3900 ohms

T1: RF Transformer; low-loss ferrite core; unloaded Q (mounted in chassis), 212 at 1 Mc. Primary: 75 turns of 7/41 Litz wire space wound (spacing equal to diameter of wire) in single layer and centered on core; reflected resistance with secondary terminated, 0.3 megohm; inductance (approx.), 353 microhenries. Secondary: 4.5 turns of No.34 SSE wire wound on ground end of core.

T2: Oscillator Transformer; low-loss ferrite core; unloaded Q (mounted in chassis), 100 at 1.455 Mc. Primary: 133 turns of 7/41 Litz wire between terminals 1 and 2; inductance (approx.); 207 microhenries. Secondary: 10 turns of No.34 SSE wire between terminals 3 and 4; 4 turns of No.34 SSE wire between terminals 5 and 6.

T3: IF Transformer; ferrite core; unloaded Q (mounted in chassis), 110 at 455 kc; loaded Q (mounted in chassis), 35 at 455 kc. Turns ratios: terminals 1 and 3 to terminals 2 and 3, 1.17; terminals 2 and 3 to terminals 4 and 5, 14.35; terminals 1 and 3 to terminals 4 and 5, 16.8. Primary: reflected resistance with secondary terminated, 0.206 megohm. Secondary: reflected resistance with primary terminated, 1000 ohms.

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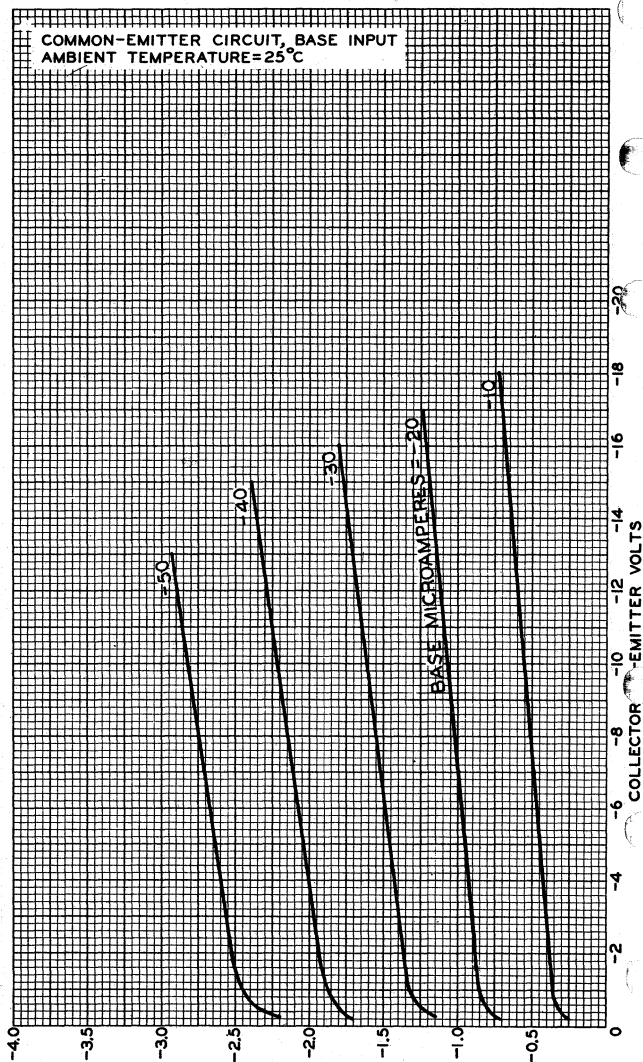
2N140



2N140

AVERAGE COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT
AMBIENT TEMPERATURE = 25°C



COLLECTOR MILLIAMPERES
SEMICONDUCTOR DIVISION

RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

92CM-9015

Power Transistor

GERMANIUM P-N-P ALLOY TYPE

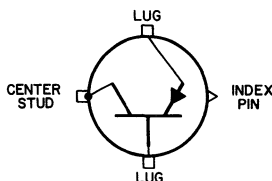
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position. Any
Maximum Seated Length 0.520"
Maximum Diameter. 1.250"
Dimensional Outline JEDEC No. TO-36
Case. Welded, Metal
Seals Hermetic
Terminal Diagram (See *Dimensional Outline*):

BOTTOM VIEW



INDUSTRIAL SERVICE

*Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and audio-
amplifier, relay- and solenoid-actuating circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter-to-base reverse biased

(DC emitter-to-base volts = 1.5). -60 max. volts

EMITTER-TO-BASE VOLTAGE -40 max. volts

COLLECTOR CURRENT -15 max. amp

EMITTER CURRENT 15 max. amp

BASE CURRENT. -4 max. amp

TRANSISTOR DISSIPATION:^a

At case temperatures^b of 25° C or below 150 max. watts

CASE TEMPERATURE^b RANGE:

Operating and storage -65 to +100 °C

Typical Operation:

*In a common-emitter, base-input, power-switch-
ing circuit at case temperature^b of 25° C*

DC Supply Voltage -12 volts

DC Base-Bias Voltage. 6 volts

"On" DC Collector Current -12 amp

"Turn-On" Base Current. -2 amp

"Turn-Off" Base Current 0 amp

← Indicates a change.



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Semiconductor & Materials Division
Somerville, N. J.

DATA I
8-61

Switching Time:

Rise time	15	μ sec
Fall time	15	μ sec

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

^b Measured at any point on seating surface.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25° C unless otherwise specified
Min. Typical Max.

DC Collector-to Emitter

Breakdown Voltage:

With base connected to emitter, dc collector

amperes = -0.3. BV_{CES} -50 - - volts

With base open:

For dc collector amperes = -0.3. BV_{CEO} - - -50 - volts

For dc collector amperes = -1^c. -45 - - volts

DC Base-to-Emitter Voltage

for dc collector-to-

emitter volts = -2, dc collector amperes = -5. V_{BE} - -0.65 - volt

DC Collector-to-Emitter

Saturation Voltage for

dc collector amperes = -12, dc base amperes = -2. V_{CE} - -0.3 -0.7 volt

DC Emitter Voltage for dc collector volts = -80,

dc emitter current = 0. V_{EB} - -0.15 -1 volt

DC Punch-Through Voltage. V_{PT}

-60 - - volts

DC Emitter-Cutoff Current

for dc emitter volts = -40, dc collector current = 0. I_{EBO} - -1 -4 ma

DC Collector-Cutoff

Current: I_{CBO} - -100 - μ a

With dc collector volts = -2, dc emitter current = 0. - -2 -4 μ a

With dc collector volts = -60, dc emitter current = 0. - -15 ma

With dc collector volts = -60, dc emitter current = 0, case temperature^b = 71° C. - - -15 ma

→ Indicates a change.



DC Current Transfer Ratio for dc collector-to- emitter volts = -2, dc collector amperes =	h_{FE}			
-5.		35	-	70
-12		-	25	-
Beta-Cutoff Frequency for dc collector-to-emitter volts = -6, dc collector amperes = -5.	f_{ae}	-	10	-
Thermal Resistance: Junction-to-case.	R_T	-	0.35	0.5 °C/watt
Thermal Capacity for pulse duration of 1 to 10 milliseconds.		-	0.075	-
				watt- sec/°C
Thermal Time Constant . . .	τ_1	-	26.25	-
				msec

^b Measured at any point on seating surface.

^c Tested by sweep method to prevent excessive heating of collector junction.

PERFORMANCE TESTS

This transistor type is designed to pass the environmental tests specified in Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connection can be made to the base and emitter lugs by means of clips or by soldering directly to the lugs. When soldering connections are made to the lugs, care should be taken to conduct excessive heat away from the lug seals, otherwise the heat of the soldering operation will crack the glass seals of the lugs and damage the transistor.

This transistor is provided with a single-ended stud for mounting to a heat sink and for electrical connection to the collector. (See accompanying *Suggested Mounting Arrangement*). Electrical connection to the base and to the emitter is made to their respective lugs.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

The maximum torque on mounting stud should not exceed 12 inch-pounds.

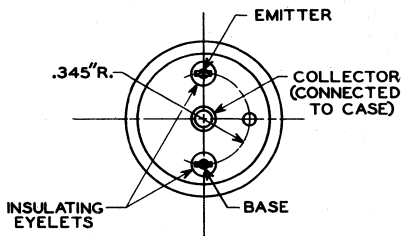
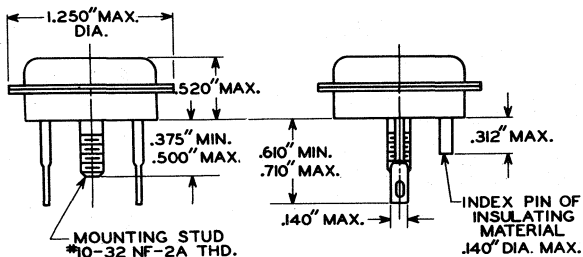
← Indicates a change.



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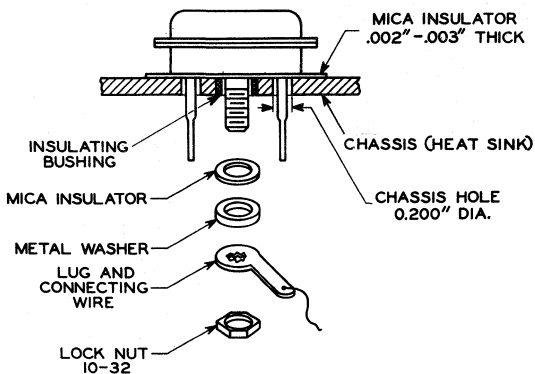
DATA 2
8-61

JEDEC No. T0-36



92CM-10612RI

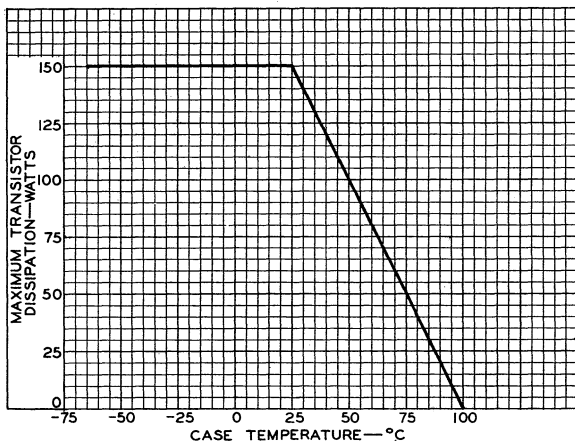
SUGGESTED MOUNTING ARRANGEMENT



92CS-10624RI

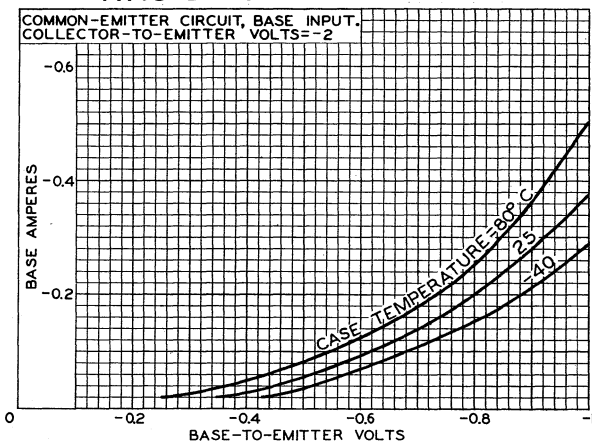


RATING CHART



92CS-10702RI

TYPICAL BASE CHARACTERISTICS



92CS-10703

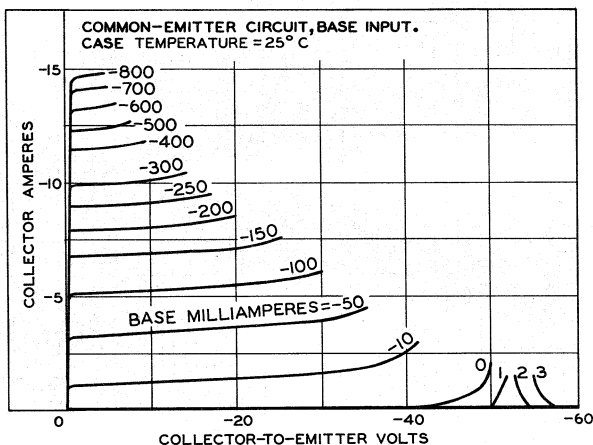


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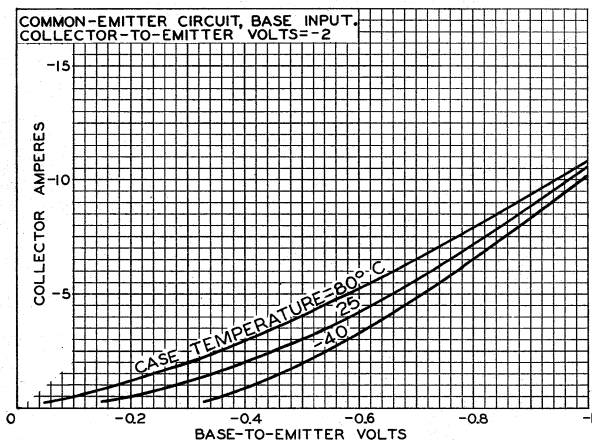
DATA 3
8-61

TYPICAL COLLECTOR CHARACTERISTICS



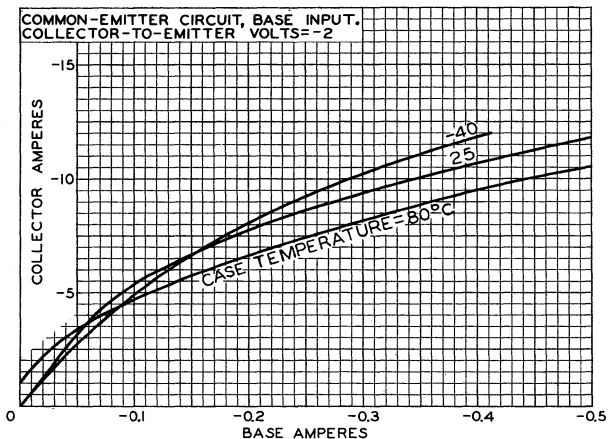
92CS-10722

TYPICAL CHARACTERISTICS



92CS-10709

TYPICAL CHARACTERISTICS



92CS-10712



Power Transistor

GERMANIUM P-N-P ALLOY TYPE

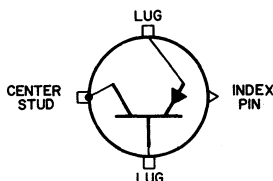
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Seated Length	0.520"
Maximum Diameter.	1.250"
Dimensional Outline	JEDEC No. TO-36
Case.	Welded, Metal
Seals	Hermetic
Terminal Diagram (See <i>Dimensional Outline</i>):	

BOTTOM VIEW



INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and audio-amplifier, relay- and solenoid-actuating circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter-to-base reverse biased

(DC emitter-to-base volts = 1.5).

-80 max. volts

EMITTER-TO-BASE VOLTAGE

-60 max. volts

COLLECTOR CURRENT

-15 max. amp

EMITTER CURRENT

15 max. amp

BASE CURRENT.

-4 max. amp

TRANSISTOR DISSIPATION:^a

At case temperatures^b of 25° C or below

150 max. watts

CASE-TEMPERATURE^b RANGE:

Operating and storage

-65 to +100 °C

Typical Operation:

In a common-emitter, base-input, power-switching circuit at case temperature^b of 25° C

DC Supply Voltage -12 volts

DC Base-Bias Voltage. 6 volts

"On" DC Collector Current -12 amp

"Turn-On" Base Current. -2 amp

"Turn-Off" Base Current 0 amp

← Indicates a change.



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DATA 1
8-61

Switching Time:

Rise time	15	μ sec
Fall time	15	μ sec

- ^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.
^b Measured at any point on seating surface.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25° C unless otherwise specified

Min. Typical Max.

DC Collector-to-Emitter

Breakdown Voltage:

With base connected
to emitter, dc
collector amperes

= -0.3 BV_{CES} -70 - - volts

With base open:

For dc collector
amperes = -1^c BV_{CEO} -55 - - volts

DC Base-to-Emitter Voltage

for dc collector-to-
emitter volts = -2, dc
collector amperes = -5. V_{BE}

- -0.65 -0.9 volt

DC Collector-to-Emitter

Saturation Voltage for dc
collector amperes = -12,
dc base amperes = -2. V_{CE}

- -0.3 -0.7 volt

DC Emitter Voltage for dc (sat)

collector volts = -80,
dc emitter current = 0. V_{EB}

- - -1 volt

DC Punch-Through Voltage. V_{PT}

-80 - - volts

DC Emitter-Cutoff Current

for dc emitter volts =
-60, dc collector
current = 0 I_{EBO}

- -1 -4 ma

DC Collector-Cutoff Current: I_{CBO}

With dc collector volts
= 2, dc emitter
current = 0

- -100 - μ a

With dc collector volts

= -80, dc emitter

current = 0 -2 -4 ma

With dc collector volts

= -80, dc emitter

current = 0, case
temperature^b = 71° C -15 ma

DC Current Transfer Ratio h_{FE}

for dc collector-to-
emitter volts = -2, dc
collector amperes =

-5. 25 - 50

-12 - 20 -

→ Indicates a change.



Beta-Cutoff Frequency for
dc collector-to-emitter
volts = -6, dc collector
amperes = -5. f_{ae} - 10 - kc

Thermal Resistance:

Junction-to-case. R_T - 0.35 0.5 °C/watt

Thermal Capacity for pulse
duration of 1 to 10
milliseconds. - 0.075 - watt-
sec/°C

Thermal Time Constant . . . τ_1 - 26.25 - msec

^b Measured at any point on seating surface.

^c Tested by sweep method to prevent excessive heating of collector junction.

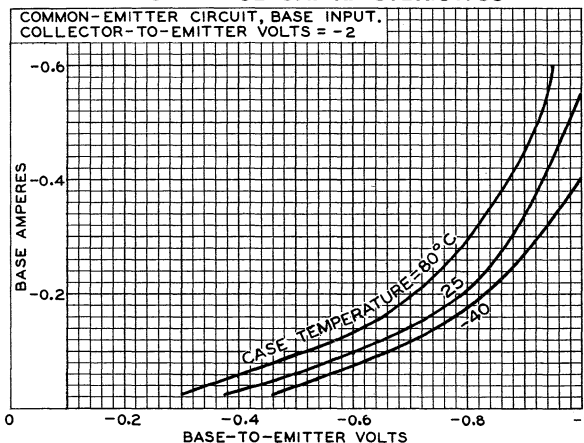
PERFORMANCE TESTS, OPERATING CONSIDERATIONS, DIMENSIONAL OUTLINE, SUGGESTED MOUNTING ARRANGEMENT, and

RATING CHART

shown under Type 2N173 also apply to the 2N174

← Indicates a change.

TYPICAL BASE CHARACTERISTICS



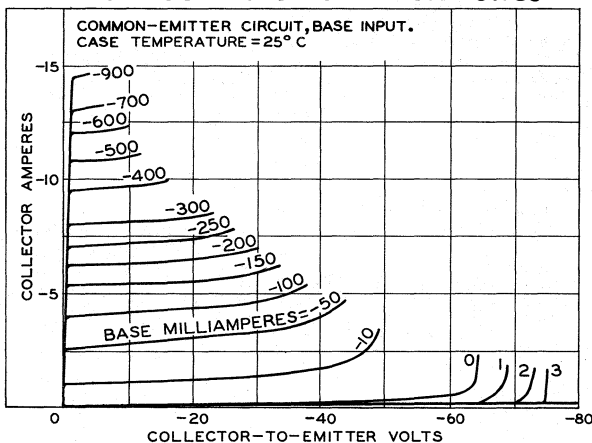
92CS-10706



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Semiconductor & Materials Division
Somerville, N. J.

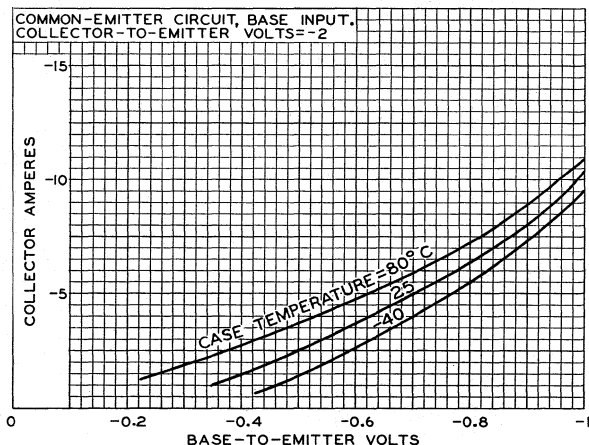
DATA 2
8-61

TYPICAL COLLECTOR CHARACTERISTICS



92CS-10736

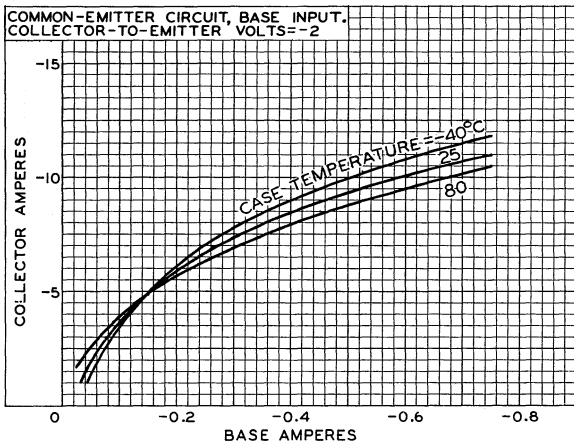
TYPICAL CHARACTERISTICS



92CS-10710

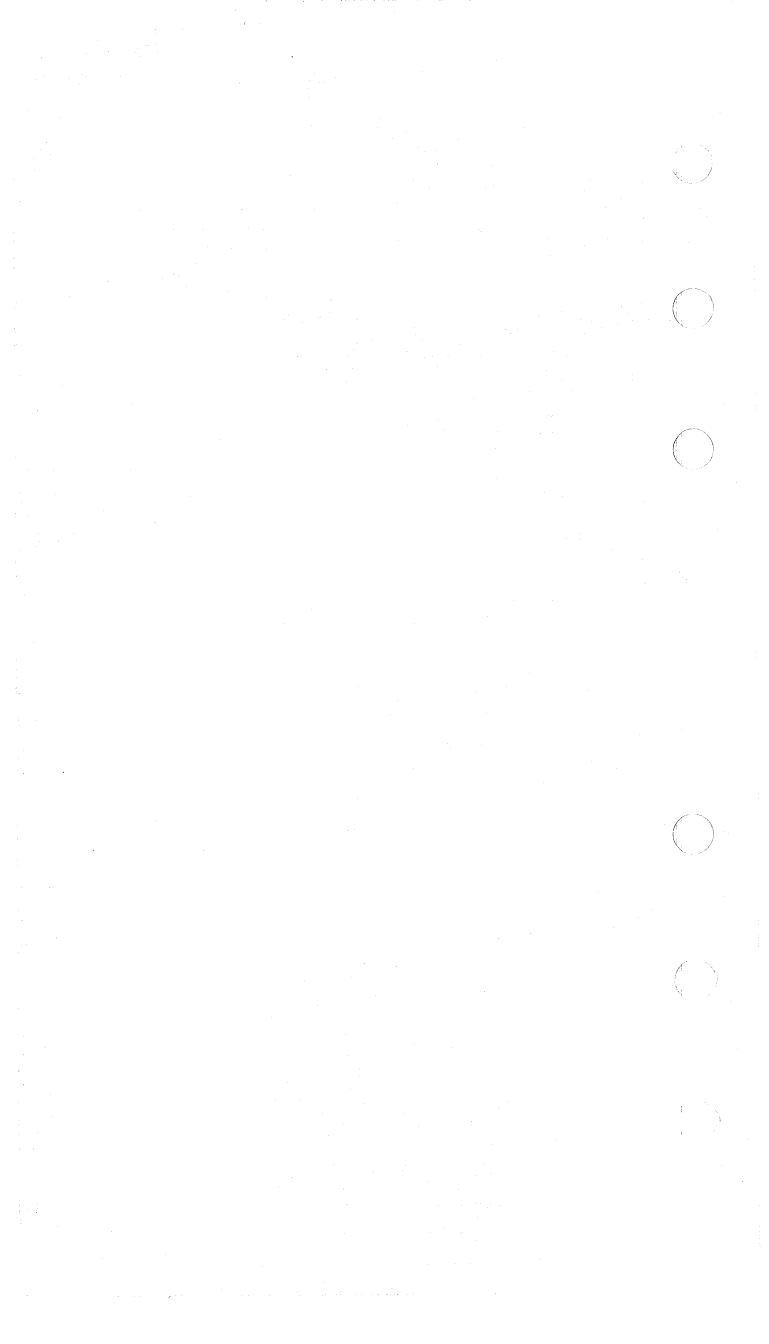


TYPICAL CHARACTERISTICS



92CS-10711







2N175

2N175

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For low-noise audio-frequency applications

GENERAL DATA

Electrical:

Maximum DC Collector Current for dc collector-to-base voltage of -25 volts with emitter open, and at ambient temperature of 25°C.	-12	μamp
Maximum DC Emitter Current for dc emitter-to-base voltage of -12 volts with collector open, and at ambient temperature of 25°C.	-12	μamp

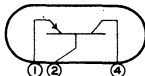
Mechanical:

Mounting Position.	Any
Maximum Overall Length.	0.697"
Maximum Seated Length.	0.495"
Maximum Diameter.	0.260"
Dimensional Outline.	See front of this Section
Case.	Metal, Insulated
Envelope Seals.	Hermetic
Base.	Small-Round Linotetlar 3-Pin (JEDEC No. E3-25)

Pin 1 - Emitter

Pin 4 - Collector

Pin 2 - Base



AUDIO-FREQUENCY AMPLIFIER -- Class A

Maximum Ratings, Absolute Values:

DC COLLECTOR-TO-BASE VOLTAGE.	-10 max.	volts
DC EMITTER-TO-BASE VOLTAGE.	-10 max.	volts
DC COLLECTOR CURRENT.	-2 max.	ma
DC EMITTER CURRENT.	2 max.	ma
COLLECTOR DISSIPATION.	20 max.	mw
AMBIENT TEMPERATURE (During operation). . .	50 max.	°C
STORAGE-TEMPERATURE RANGE.	-55 to +85	°C

Characteristics, At Ambient Temperature of 25°C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage.	-4	volts
DC Collector Current.	-0.5	ma

Power Gain:

With load resistance = 0.07 megohm, and input resistance = 2000 ohms.	43	db
--	----	----

Noise Factor:

Measured with a noise diode and thermo- couple voltmeter with load resistance = 20,000 ohms, generator resistance = 1000 ohms, and equivalent noise band- width = 12.3 kc with geometric mean of 300 cps: Maximum value.	6	db
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6-56.

SEMICONDUCTOR DIVISION

RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

TENTATIVE DATA



2N175

JUNCTION TRANSISTOR

Small-Signal T Parameters:*

DC Collector-to-Emitter Voltage (V_{CE})	-4	volts
DC Collector Current (I_C)	-0.5	ma
Emitter Resistance (r_e)	37.7	ohms
Base Resistance (r_b)	1085	ohms
Mutual Resistance (r_m)	2.82	megohms
Collector Resistance (r_c)	2.86	megohms
Current Transfer Ratio (α_f)	-65	

Small-Signal Hybrid- π Parameters:*

DC Collector-to-Emitter Voltage (V_{CE})	-4	volts
DC Collector Current (I_C)	-0.5	ma
Resistance $r_{bb'}$	190	ohms
Conductance $g_{b'e}$	296	μ hos
Conductance g_{ce}	6.6	μ hos
Conductance $g_{b'c}$	0.279	μ ho
Capacitance $C_{b'e}$	3900	μ f
Capacitance $C_{b'c}$	36	μ f
Intrinsic Transconductance (g_m)	19200	μ hos
Frequency* for unity power amplification	2.06	Mc

Small-Signal H Parameters:*

DC Collector-to-Emitter Voltage (V_{CE})	-4	volts
DC Collector Current (I_C)	-0.5	ma
Input Resistance, output circuit shorted (h_i)	3570	ohms
Reverse Voltage Transfer Ratio, input circuit open (h_r)	9.44×10^{-4}	
Forward Current Transfer Ratio, output circuit shorted (h_f)	65	
Output Conductance, input circuit open (h_o)	25	μ hos

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-4	volts
DC Collector Current	-0.5	ma
Frequency at which the current transfer ratio drops to one-half the square root of two times its value at 1 kc.	0.85	Mc

OPERATING CONSIDERATIONS

The 2N175 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

* As derived from corresponding equivalent circuit shown under type 2N104.

■ Measured at 1 kc.

● This frequency (figure of merit) may be calculated from the equation

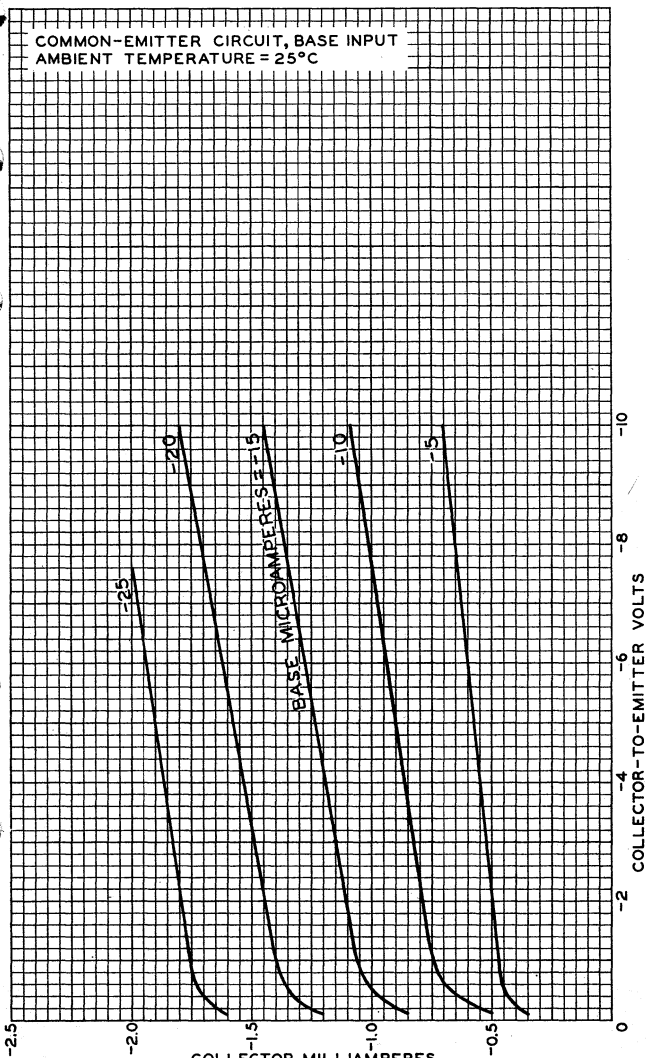
$$f = \frac{1}{4\pi} \sqrt{\frac{g_m}{r_{bb'} C_{b'e} C_{b'c}}}$$



2N175

2N175

AVERAGE COLLECTOR CHARACTERISTICS



SEMICONDUCTOR DIVISION
RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

92CM-8914R1

2N175



2N175

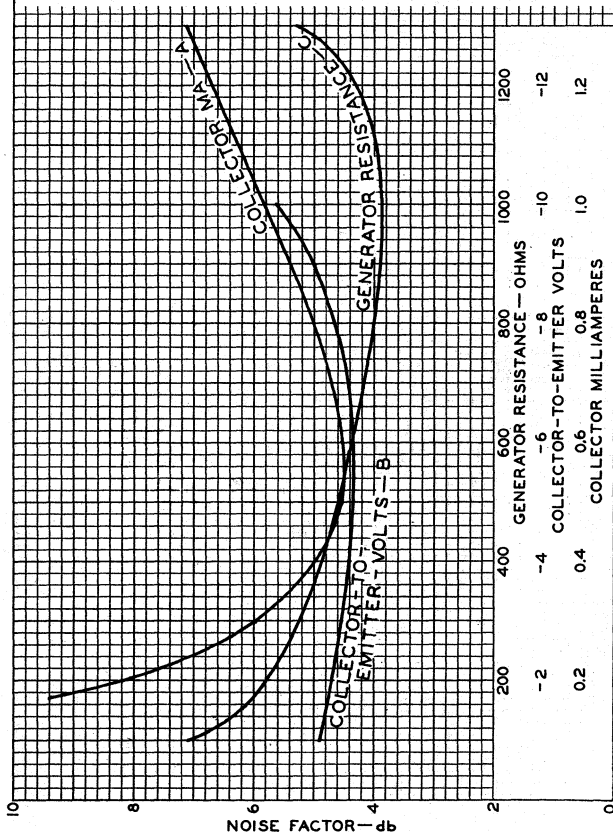
TYPICAL NOISE CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT

AMBIENT TEMPERATURE = 25°C

MEASURED WITH A NOISE DIODE AND THERMOCOUPLE VOLT-METER WITH LOAD RESISTANCE = 20000 OHMS AND EQUIVALENT NOISE BANDWIDTH = 12.3 KC WITH GEOMETRIC MEAN OF 300 CPS

CURVE	GENERATOR RESISTANCE (OHMS)	COLLECTOR-TO-EMITTER VOLTS	COLLECTOR MA
A	1000	-4	—
B	1000	—	-0.5
C	—	-4	-0.5



SEMICONDUCTOR DIVISION

RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

92CM-8913RI



2N176

2N176

POWER TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

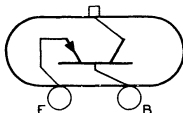
*For audio-frequency power applications***GENERAL DATA****Electrical:**

Minimum DC Collector-to-Emitter Voltage (BV_{CE}) for dc collector ma. = -330 with base connected to emitter, and for mounting-flange temperature of 25° C.	-30	volts
Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = -30 with emitter open, and for mounting-flange temperature of 25° C.	-3	ma
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = -10 with collector open, and for mounting-flange temperature of 25° C.	-2	ma
Junction-Temperature Rise (In free air). . .	1	°C/watt

Mechanical:

Operating Position	Any
Maximum Overall Length	0.80"
Maximum Seated Length.	0.41"
Maximum Length of Mounting Flange.	1.562"
Maximum Width of Mounting Flange	1.12"
Case	Metal
Mounting Flange.	Metal
Envelope Seals	Hermetic
Terminal Connections (<i>See Dimensional Outline</i>):	

E - Emitter

MOUNTING FLANGE-
Collector

B - Base

AUDIO-FREQUENCY POWER AMPLIFIER — Class A**Maximum Ratings, Absolute Values:**

PEAK COLLECTOR-TO-BASE VOLTAGE	-40 max.	volts
PEAK COLLECTOR CURRENT	-3 max.	amp
PEAK EMITTER CURRENT	3 max.	amp
TRANSISTOR DISSIPATION:*		
For mounting-flange temperature of 80° C.	10 max.	watts
MOUNTING-FLANGE TEMPERATURE (During operation)	90 max.	°C
STORAGE-TEMPERATURE RANGE.	-65 to +90	°C

*: See next page.

2N176



2N176

POWER TRANSISTOR

Characteristics, For Mounting-Flange Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage	-2	volts
DC Collector Current	-0.5	amp
Small-Signal Input Resistance	13.5	ohms
Small-Signal Current Transfer Ratio	-45	
Large-Signal DC Current Transfer Ratio	63	

Typical Operation, For Mounting-Flange Temperature of 80° C:*Common-Emitter Circuit, Base Input*

DC Supply Voltage	-14.4	volts
DC Collector-to-Emitter Voltage	-13.7	volts
Emitter Resistor	1	ohm
DC Base-to-Emitter Voltage	-0.24	volt
DC Collector Current:		
Peak	-1	amp
Zero-Signal	-0.5	amp
Zero-Signal Collector Dissipation	6.83	watts
Signal-Source Impedance	10	ohms
Load Impedance	25	ohms
Signal Frequency	1	kc
Power Gain	35.5	db
Total Harmonic Distortion	4	%
Max.-Signal Power Output	2	watts

AUDIO-FREQUENCY POWER AMPLIFIER — Class B**Maximum Ratings, Absolute Values:**

PEAK COLLECTOR-TO-BASE VOLTAGE	-40 max.	volts
PEAK COLLECTOR CURRENT	-3 max.	amp
PEAK EMITTER CURRENT	3 max.	amp
TRANSISTOR DISSIPATION:		
For mounting-flange temperature of 80° C.	10 max.	watt
MOUNTING-FLANGE TEMPERATURE (During operation)	90 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +90	°C

* The maximum transistor-dissipation rating is reduced 1 watt for each degree centigrade the mounting-flange temperature is increased above 80° C.

• Measured at a signal frequency of 1 kc.

OPERATING CONSIDERATIONS

The base and emitter pins of the 2N176 fit the Loranger Mfg. Corp. Socket No. 2149, or equivalent. When a socket is not used, connections can be soldered directly to the base and emitter pins. Soldering of the connections to the pins may be made close to the pin seals provided care is taken to conduct excessive heat away from the pin seals. Otherwise, the heat of the soldering operation will crack the glass seals of the pins and damage the transistor.



2N176

2N176

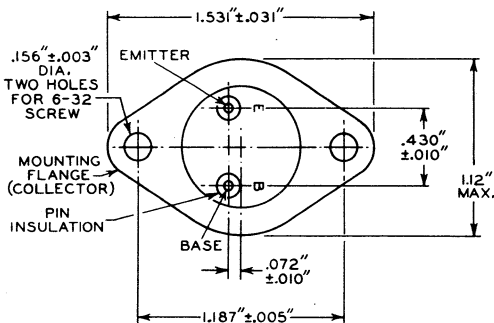
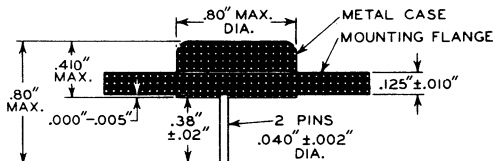
POWER TRANSISTOR

It is important that the mounting flange which serves as the collector for the 2N176 be securely fastened to a heat sink. Depending on the application, the chassis (heat sink) may be connected either to the positive or negative terminal of the voltage supply.

It is to be noted that the metal shell of the 2N176 operates at the collector voltage. Consideration, therefore, should be given to the possibility of shock hazard if the metal shell of this transistor is to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

Under no circumstances should the mounting flange be soldered to the heat sink because the heat of the soldering operation will permanently damage the transistor.

The 2N176 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.



92CS-9624





2N215

2N215

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For small-signal audio-frequency applications

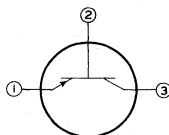
The 2N215 is the same as the 2N104 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads) 0.455"
 Leads, Flexible. 3
 Length 1.5" $\pm$ 0.015"
 Orientation and diameter See Dimensional Outline

BOTTOM VIEW

Lead 1 - Emitter



Lead 3 - Collector
 (Adjacent
 to red dot
 on side of
 envelope)

Lead 2 - Base

OPERATING CONSIDERATIONS

The 2N215 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N215 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

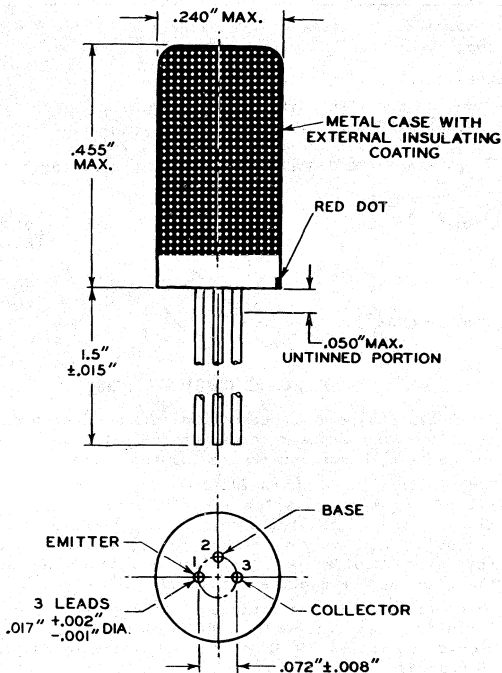
When dip soldering is employed in the assembly of printed circuitry using the 2N215, the temperature of the solder should not exceed 230°C for a maximum immersion period of 10 seconds.

2N215



2N215

JUNCTION TRANSISTOR



92CS-9026



2N217

2N217

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For large-signal audio-frequency applications

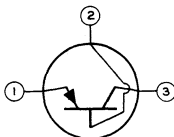
*The 2N217 is the same as the 2N109 except for the following items:***Mechanical:**

Maximum Length (Excluding flexible leads)	0.405"	
Maximum Diameter	0.240"	
Dimensional Outline	JEDEC No. TO-1	←
Leads, Flexible	3	
Minimum length	1.5"	←
Orientation and diameter	See Dimensional Outline	
Base	JEDEC No. E3-39	←

BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector
(Adjacent
to red dot
on side of
case)**OPERATING CONSIDERATIONS**

The 2N217 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N217 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N217, the temperature of the solder should not exceed 230° C for a maximum immersion period of 10 seconds.

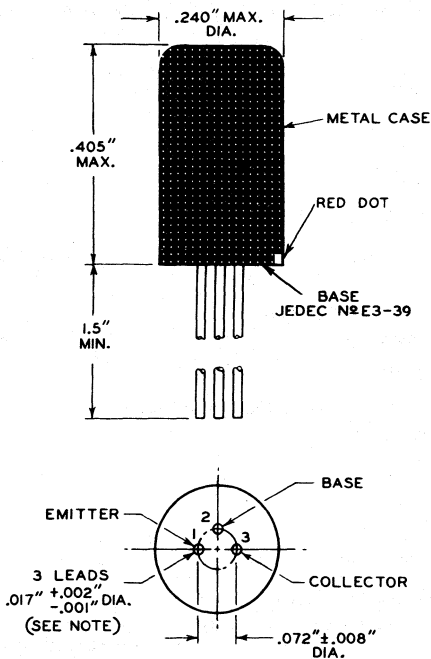
← Indicates a change.

2N217



2N217

JUNCTION TRANSISTOR



92CS-9148R4

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



2N218

2N218

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For 455-kc intermediate-frequency applications

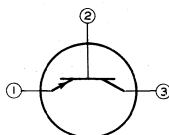
The 2N218 is the same as the 2N139 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads) 0.405"
 Leads, Flexible 3
 Length 1.5" $\pm$ 0.015"
 Orientation and diameter See Dimensional Outline

BOTTOM VIEW

Lead 1 - Emitter



Lead 3 - Collector
 (Adjacent
 to red dot
 on side of
 envelope)

Lead 2 - Base

OPERATING CONSIDERATIONS

The 2N218 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N218 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

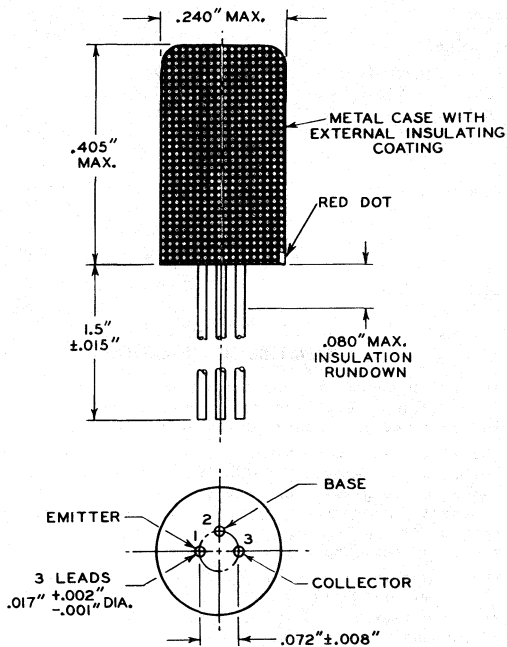
When dip soldering is employed in the assembly of printed circuitry using the 2N218, the temperature of the solder should not exceed 230°C for a maximum immersion period of 10 seconds.

2N218



2N218

JUNCTION TRANSISTOR



92CS-9025



2N219

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For 540 to 1600 kc converter applications

2N219

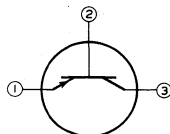
The 2N219 is the same as the 2N140 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads) 0.405"
 Leads, Flexible 3
 Length. 1.5" $\pm$ 0.015"
 Orientation and diameter. See Dimensional Outline

BOTTOM VIEW

Lead 1 - Emitter



Lead 3 - Collector
 (Adjacent
 to red dot
 on side of
 envelope)

Lead 2 - Base

OPERATING CONSIDERATIONS

The 2N219 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N219 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

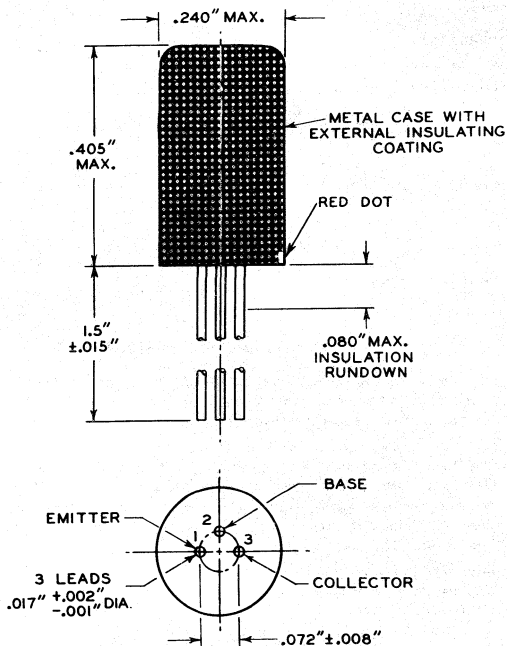
When dip soldering is employed in the assembly of printed circuitry using the 2N219, the temperature of the solder should not exceed 230°C for a maximum immersion period of 10 seconds.

2N219



2N219

JUNCTION TRANSISTOR



92CS-9025



2N220

2N220

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For low-noise audio-frequency applications

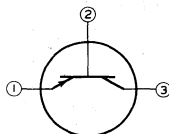
The 2N220 is the same as the 2N175 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads) 0.405"
 Leads, Flexible. 3
 Length $1.5" \pm 0.015"$
 Orientation and diameter See Dimensional Outline

BOTTOM VIEW

Lead 1 - Emitter



Lead 3 - Collector
 (Adjacent
 to red dot
 on side of
 envelope)

Lead 2 - Base

OPERATING CONSIDERATIONS

The 2N220 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The flexible leads of the 2N220 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

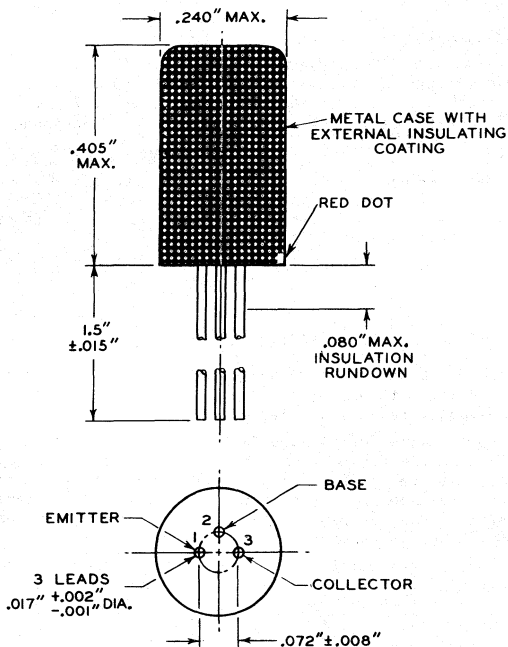
When dip soldering is employed in the assembly of printed circuitry using the 2N220, the temperature of the solder should not exceed 230°C for a maximum immersion period of 10 seconds.

2N220



2N220

JUNCTION TRANSISTOR



92CS-9025



2N270

2N270

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For large-signal audio-frequency applications

GENERAL DATA

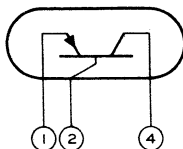
Electrical:

Maximum DC Collector Current for dc collector-to-base voltage of -25 volts with emitter open, and at ambient temperature of 25° C.	-16	μa	←
Maximum DC Emitter Current for dc emitter-to-base voltage of -12 volts with collector open, and at ambient temperature of 25° C.	-12	μa	←
Maximum Junction-Temperature Rise (With transistor in free air)	0.24	°C/mw	

Mechanical:

Operating Position.	Any		
Maximum Length (Excluding flexible leads)	0.375"		
Maximum Diameter.	0.360"		
Case.	Metal		←
Envelope Seals.	Hermetic		
Leads, Flexible.	3		
Minimum length.	1.5"		
Orientation and diameter.	See Dimensional Outline		

Lead 1 - Emitter



Lead 4 - Collector

Lead 2 - Base

AUDIO-FREQUENCY AMPLIFIER — Class A

Maximum Ratings, Absolute-Maximum Values:

PEAK COLLECTOR-TO-BASE VOLTAGE.	-25 max.	volts	
DC COLLECTOR-TO-BASE VOLTAGE.	-25 max.	volts	←
PEAK EMITTER-TO-BASE VOLTAGE.	-12 max.	volts	←
DC EMITTER-TO-BASE VOLTAGE.	-12 max.	volts	←
PEAK COLLECTOR CURRENT.	-150 max.	ma	
DC COLLECTOR CURRENT.	-75 max.	ma	
PEAK EMITTER CURRENT.	150 max.	ma	
DC EMITTER CURRENT.	75 max.	ma	
TRANSISTOR DISSIPATION:			←
At an ambient temperature of 25° C.	250 max.	mw	
At an ambient temperature of 55° C.	150 max.	mw	
At an ambient temperature of 71° C.	60 max.	mw	
AMBIENT TEMPERATURE (During operation).	71 max.	°C	←
STORAGE-TEMPERATURE RANGE	-65 to +85	°C	

← Indicates a change.



2N270

JUNCTION TRANSISTOR

Characteristics, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage	-1	volt
DC Collector Current	-150	ma
Large-Signal DC Current Gain	70	

→ Typical Operation, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Supply Voltage	-9	volts
DC Collector-to-Emitter Voltage	-6.7	volts
Emitter Resistor	100	ohms
Emitter-Bypass Capacitor	50	μf
DC Collector Current	-19	ma
DC Base-to-Emitter Voltage	-0.19	volt
Input Resistance	400	ohms
Load Impedance	400	ohms
Signal Frequency	1	kc
Power Gain	35	db
Total Harmonic Distortion	10 [▲] max.	%
Max.-Signal Power Output	60	mw
Transistor Dissipation	128	mw

AUDIO-FREQUENCY AMPLIFIER — Class B**Maximum Ratings, Absolute-Maximum Values:**

PEAK COLLECTOR-TO-BASE VOLTAGE	-25 max.	volts
→ DC COLLECTOR-TO-BASE VOLTAGE	-25 max.	volts
→ PEAK EMITTER-TO-BASE VOLTAGE	-12 max.	volts
→ DC EMITTER-TO-BASE VOLTAGE	-12 max.	volts
PEAK COLLECTOR CURRENT	-150 max.	ma
DC COLLECTOR CURRENT	-75 max.	ma
PEAK EMITTER CURRENT	150 max.	ma
DC EMITTER CURRENT	75 max.	ma
→ TRANSISTOR DISSIPATION:		
At an ambient temperature of 25° C	250 max.	mw
At an ambient temperature of 55° C	150 max.	mw
At an ambient temperature of 71° C	60 max.	mw
→ AMBIENT TEMPERATURE (During operation)	71 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C

Characteristics, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage	-1	volt
DC Collector Current	-150	ma
Large-Signal DC Current Gain	70	

◆, ▲: See next page.

→ Indicates a change.



2N270

2N270

JUNCTION TRANSISTOR

Typical Push-Pull Operation, At Ambient Temperature of 25° C:
Common-Emitter Circuit, Base Input

Unless otherwise specified, values are for 2 transistors

DC Supply Voltage	-12	volts
Emitter Resistor.	5	ohms
DC Base-to-Emitter Voltage (Zero-signal).	-0.11	volt
Peak Collector Current (Per transistor)	-110	ma
Zero-Signal DC Collector Current (Per transistor)	-2	ma
Max.-Signal DC Collector Current (Per transistor)	-35	ma
Signal-Source Impedance (Base to base).	4000	ohms
Load Impedance (Collector to collector)	600	ohms
Signal Frequency.	1	kc
Circuit Efficiency.	75	%
Power Gain♦	32	db
Total Harmonic Distortion	10 [■] max.	%
Max.-Signal Power Output♦	500	mw

♦ Measured at the primary of the output transformer.

▲ This value is 4 per cent maximum at max.-signal power output of 10 milliwatts.

■ This value is 5 per cent maximum at max.-signal power output of 10 milliwatts.

OPERATING CONSIDERATIONS

The 2N270 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N270 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N270, the temperature of the solder should not exceed 230° C for a maximum immersion period of 10 seconds.

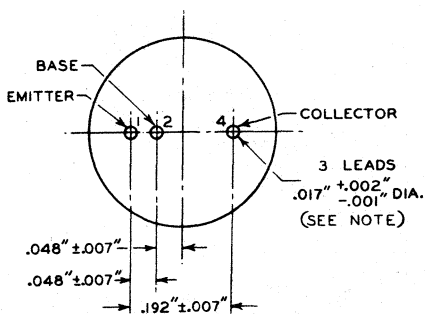
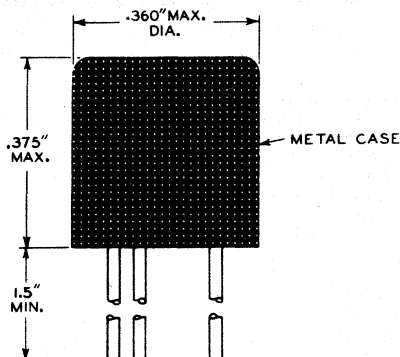
In class B service, when the 2N270 is operated at ambient temperatures other than 25° C, the base-to-emitter voltage should be reduced or increased by approximately 0.002 volt for each degree the ambient temperature is above or below 25° C, respectively. When this transistor is operated under varying ambient temperatures, some form of temperature compensation may be used in the base-to-emitter circuit to hold the operating point constant.

2N270



2N270

JUNCTION TRANSISTOR



92CS-9176R3

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.050''$ AND $0.250''$ FROM THE BASE SEAT. BETWEEN $0.250''$ AND $1.50''$ A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

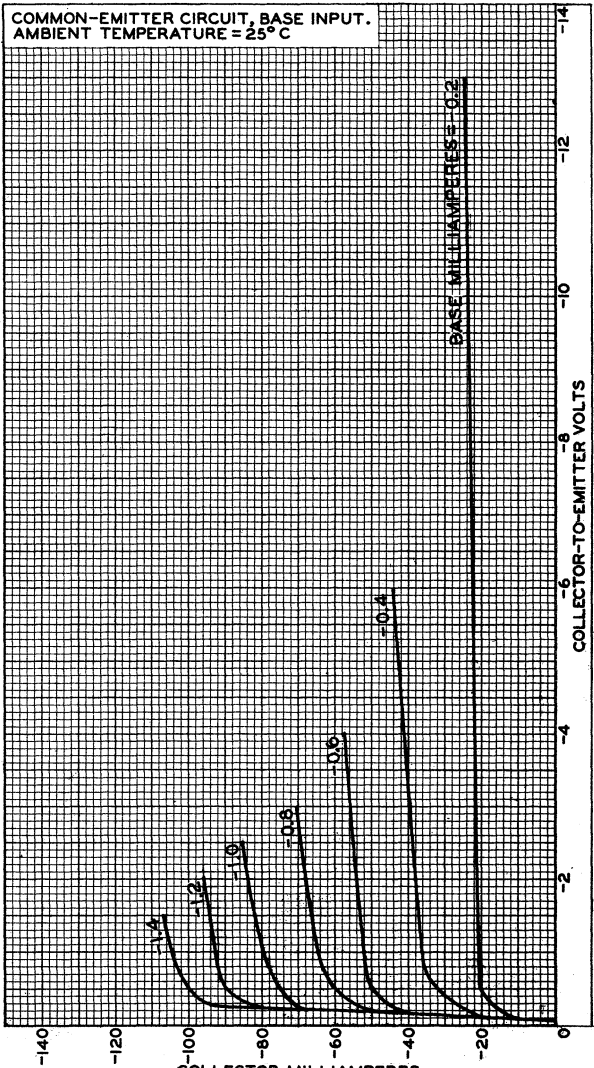


2N270

2N270

AVERAGE COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE = 25°C



COLLECTOR MILLIAMPERES
SEMICONDUCTOR and MATERIALS DIVISION
RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

92CM-9182

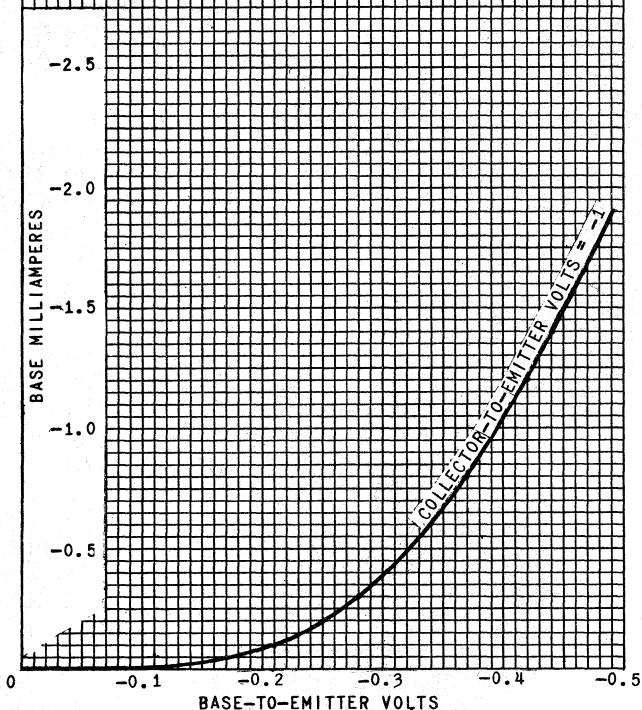
2N270



2N270

AVERAGE BASE CHARACTERISTIC

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE = 25° C

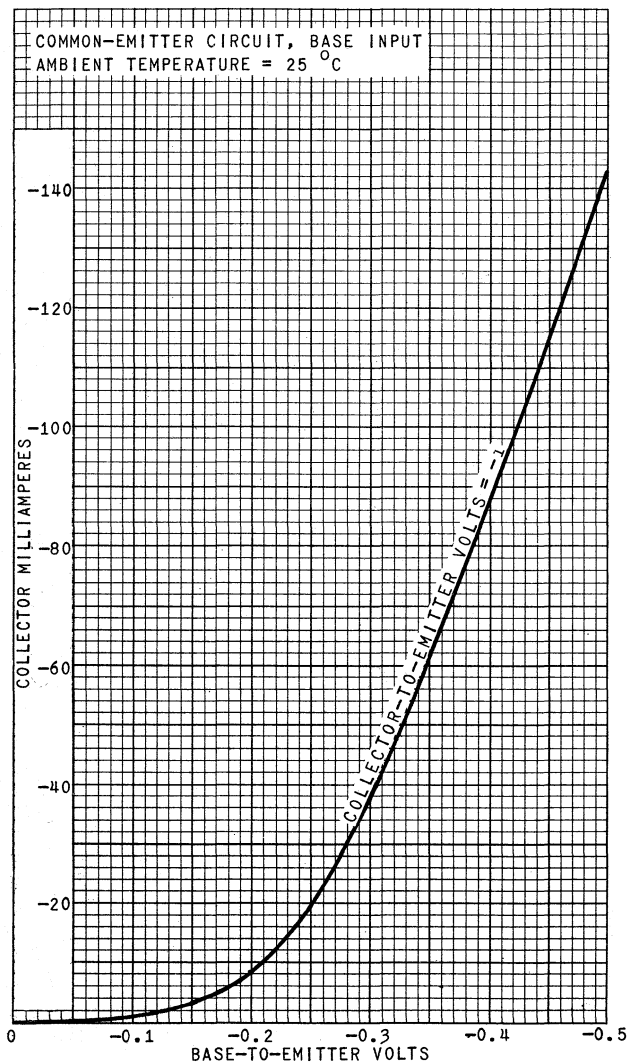




2N270

2N270

AVERAGE TRANSFER CHARACTERISTIC

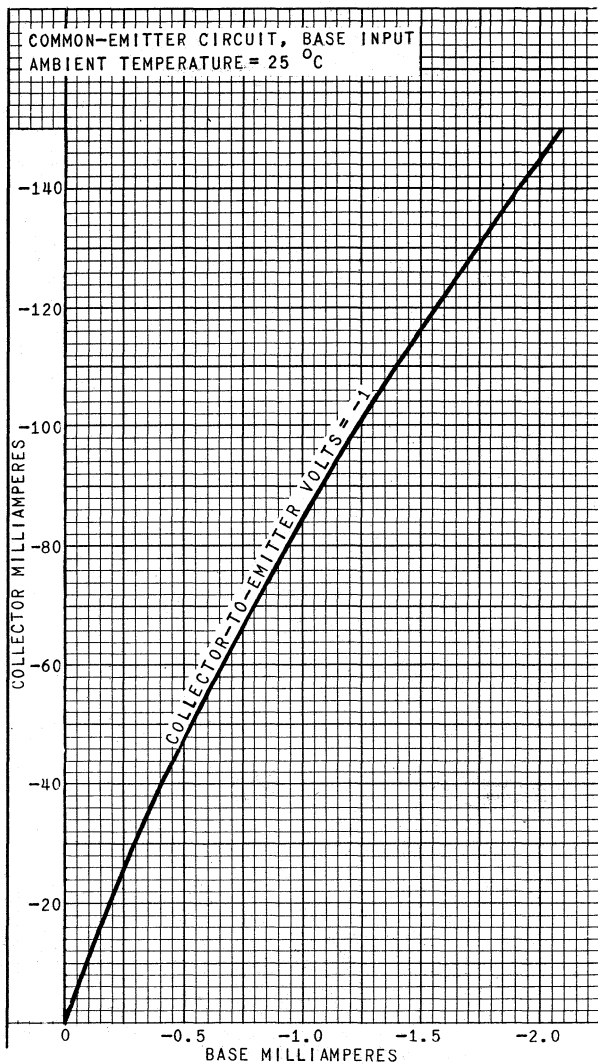


2N270



2N270

AVERAGE CURRENT-TRANSFER CHARACTERISTIC



Drift-Field Transistor

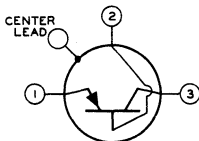
GERMANIUM P-N-P ALLOY TYPE
For Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.405"
Maximum Diameter.	0.240"
Dimensional Outline	JEDEC No. TO-44
Case.	Metal
Seals	Hermetic
Leads, Flexible	.4
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline
Terminal Diagram:	BOTTOM VIEW

Lead 1- Emitter
Center Lead -
Interlead
Shield,
Case



Lead 2- Base
Lead 3- Collector
(Adjacent
to red dot
on side of
case)

INDUSTRIAL SERVICE

Such as in rf, if, oscillator, mixer, converter, and low-level video-amplifier circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE (Emitter open).	-40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE (Base-to-emitter volts = 0.5)	-40 max.	volts
EMITTER-TO-BASE VOLTAGE	-0.5 max.	volt
COLLECTOR CURRENT	-10 max.	ma
EMITTER CURRENT	10 max.	ma
TRANSISTOR DISSIPATION (See Rating Chart):		
At ambient temperature of 25° C		
for operation in free air	120 max.	ma
At case temperature of 25° C		
for operation with heat sink.	240 max.	ma
AMBIENT-TEMPERATURE RANGE:		
Operating and storage	-65 to +100	°C

Typical Operation:

In accompanying video-amplifier circuit with ambient temperature range of -65 to +55 °C

DC Collector-to-Emitter Voltage	-12	volts
DC Emitter Current.	5.8	ma
Source Impedance.	150	ohms
Capacitive Load	16	μf

← Indicates a change.



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DATA 1
3-60

2N274

Frequency-Response Range:

Minimum	20	cps
Maximum	9	Mc
Pulse-Rise Time	0.039	μ sec
Voltage Gain	26	db
Maximum Peak-to-Peak Output Voltage . . .	20	volts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base unless otherwise specified. Ambient temperature = 25° C.

	Typical Values	Range Values Min. Max.		
DC Collector Breakdown Voltage (BV_{CBO}) with dc collector $\mu a = -50$, dc emitter $ma = 0$	-80	-40	-	volts
Punch-Through Voltage (V_P) with dc emitter volts = -0.5.	-80	-40	-	volts
DC Collector-Cutoff Current (I_{CBO}) with dc collector volts = -12, dc emitter $ma = 0$	-4	-	-12	μa
DC Emitter-Cutoff Current (I_{EBO}) with dc emitter volts = -0.5, collector open.	-1	-	-12	μa
Small-Signal Current Transfer Ratio (h_{fe}) for dc collector- to-emitter volts = -12, dc emitter $ma = 1.5$, signal frequency of 1 kc.	60	20	175	
Alpha-Cutoff Frequency ($f_{\alpha b}$) for dc collector volts = -12, dc emitter $ma = 1.5$	30	-	-	Mc
Input Resistance (R_{in}):▲ For dc collector-to-emitter volts = -12, dc emitter $ma = 1.5$, signal frequency of 12.5 Mc.	150	-	-	ohms
For dc collector-to-emitter volts = -12, dc emitter $ma = 1.5$, signal frequency of 1.5 Mc	1350	-	-	ohms
Output Resistance (R_{out}):● For dc collector-to-emitter volts = -12, dc emitter $ma = 1.5$, signal frequency of 12.5 Mc.	4000	-	-	ohms
For dc collector-to-emitter volts = -12, dc emitter $ma = 1.5$, signal frequency of 1.5 Mc	70000	-	-	ohms

→ Indicates a change.



	Typical Values	Range Values	
		Min.	Max.
Collector-to-Base Capacitance (C_{ob}) for dc collector volts = -12, dc emitter ma. = 0.	2	-	3 μf
Power Gain (PG): ■ For dc collector-to-emitter volts = -12, dc emitter ma. = 1.5, signal frequency of 12.5 Mc.	22	17	27 db
For dc collector-to-emitter volts = -12, dc emitter ma. = 1.5, signal frequency of 1.5 Mc.	45	40	50 db
Thermal Resistance (R_T): Between junction and case . .	-	-	0.31 °C/watt
Between junction and free air. .	-	-	0.62 °C/watt

▲ AC output-circuit shorted.

● AC input-circuit shorted.

■ Measured in a single-tuned unilateralized circuit matched to the generator and load impedance for maximum transfer of power (transformer-insertion losses not included).

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using this transistor, the temperature of the solder should not exceed 255° C for a maximum immersion period of 10 seconds.

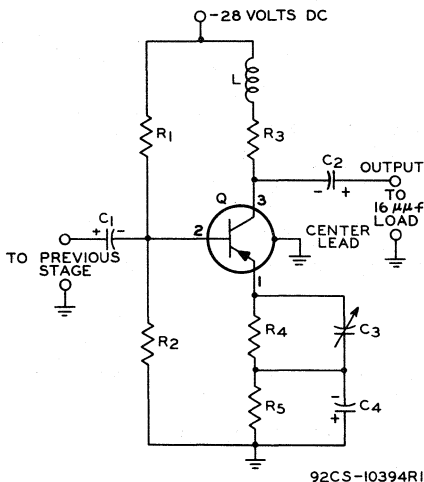
This transistor utilizes shielding to minimize interlead capacitance and coupling to adjacent circuit components. This shielding is provided by a fourth lead which is internally connected to the case. For optimum performance, it is recommended that this lead be connected to the chassis ground.

← Indicates a change.



2N274

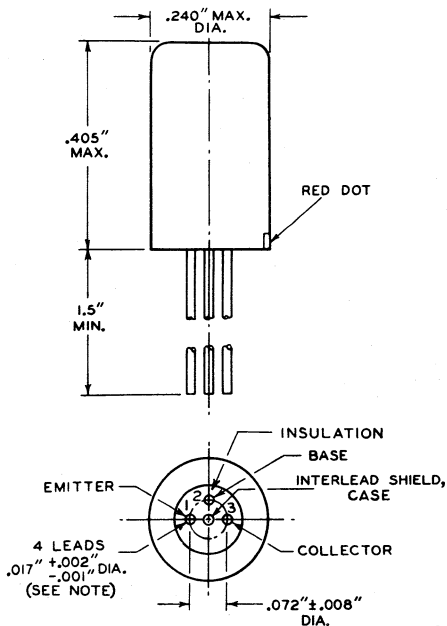
VIDEO-AMPLIFIER CIRCUIT



- C₁: 25 μ f, 12 volts
C₂: 25 μ f, 25 volts
C₃: 100 to 300 μ f (variable)
C₄: 100 μ f, 12 volts
L: 30 μ h
Q: Transistor type 2N274
R₁: 20,000 ohms, 0.25 watt
R₂: 3600 ohms, 0.25 watt
R₃: 2000 ohms, 0.25 watt
R₄: 62 ohms, 0.25 watt
R₅: 620 ohms, 0.25 watt

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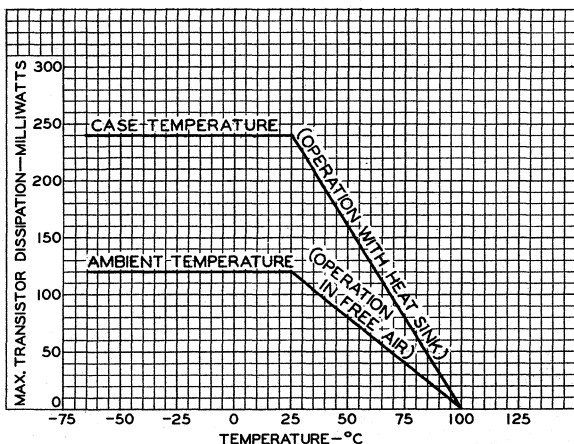


92CS-9266R2

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.050''$ AND $0.250''$ FROM THE PLANE OF THE ACTUAL BOTTOM OF THE CASE. BETWEEN $0.250''$ AND $1.50''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

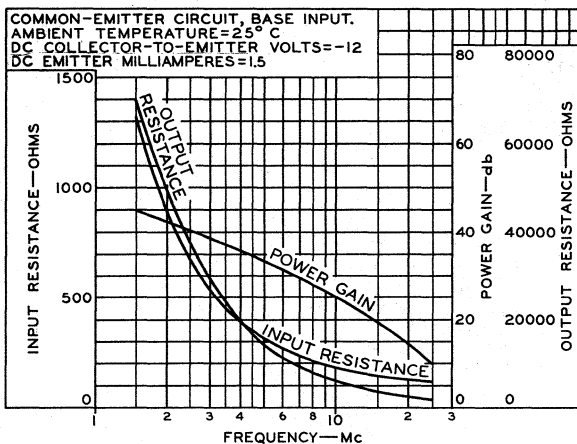


RATING CHART



92CS-1038IRI

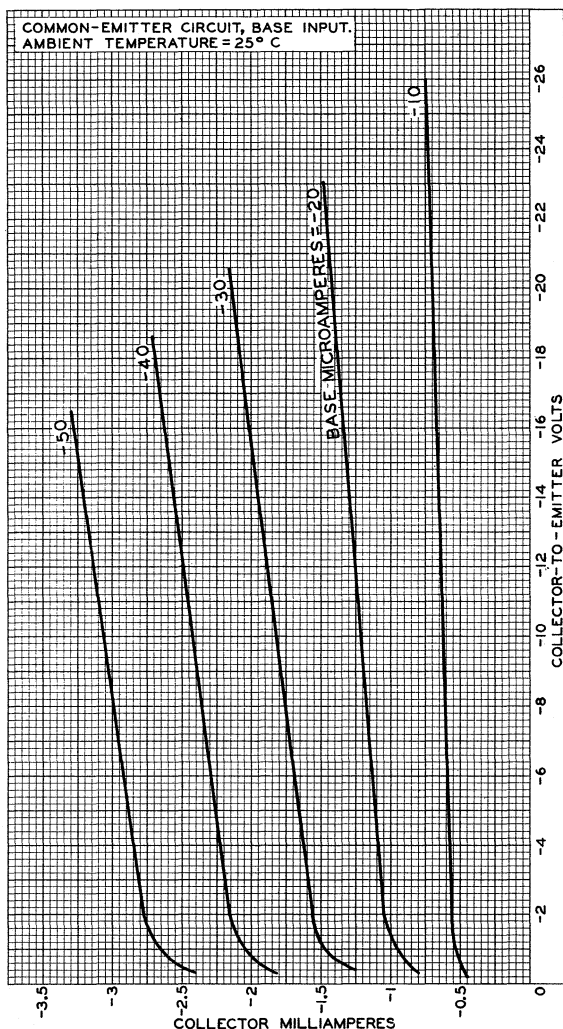
PERFORMANCE CHARACTERISTICS



92CS-10208RI



TYPICAL COLLECTOR CHARACTERISTICS



92CM-9418



Power Transistor

GERMANIUM P-N-P ALLOY TYPE

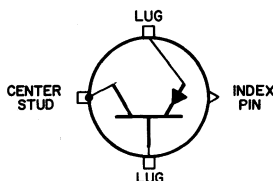
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Seated Length.	0.520"
Maximum Diameter.	1.250"
Dimensional Outline.	JEDEC No. TO-36
Case.	Welded, Metal
Seals.	Hermetic
Terminal Diagram (See <i>Dimensional Outline</i>):	

BOTTOM VIEW



INDUSTRIAL SERVICE

*Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and audio-
amplifier, relay- and solenoid-actuating circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter-to-base reverse biased

(DC emitter-to-base volts = 1.5).

-40 max. volts

EMITTER-TO-BASE VOLTAGE.

-20 max. volts

COLLECTOR CURRENT.

-15 max. amp

EMITTER CURRENT.

15 max. amp

BASE CURRENT.

-4 max. amp

TRANSISTOR DISSIPATION:^a

At case temperatures^b of 25° C or below

150 max. watts

CASE-TEMPERATURE^b RANGE:

Operating and storage.

-65 to +100 °C

Typical Operation:

*In a common-emitter, base-input, power-
switching circuit at case temperature^b of 25° C*

DC Supply Voltage.	-12	volts
DC Base-Bias Voltage.	6	volts
"On" DC Collector Current.	-12	amp
"Turn-On" Base Current.	-2	amp
"Turn-Off" Base Current.	0	amp

← Indicates a change.



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DATA 1
8-61

Switching Time:

Rise time	15	μ sec
Fall time	15	μ sec

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

^b Measured at any point on seating surface.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25° C unless otherwise specified
Min. Typical Max.

DC Collector-to-Emitter

Breakdown Voltage:

With base connected to emitter, dc collector

amperes = -0.3. BV_{CES} -40 - - volts

With base open:

For dc collector

amperes = -0.3. BV_{CEO} - - -40 - volts

For dc collector

amperes = -1^c. -25 - - volts

DC Base-to-Emitter Voltage

for dc collector-to-

emitter volts = -2, dc

collector amperes = -5. V_{BE} - -0.65 - volt

DC Collector-to-Emitter

Saturation Voltage for

dc collector amperes =

-12, dc base amperes = -2. $V_{CE(sat)}$ - -0.3 - volt

DC Emitter Voltage for dc (sat)

collector volts = -40,

dc emitter current = 0. V_{EB} - - -1 volt

DC Punch-Through Voltage. V_{PT}

-40 - - - volts

DC Emitter-Cutoff Current

for dc emitter volts =

-20, dc collector current = 0. I_{EBO} - -1 -4 ma

DC Collector-Cutoff Current: I_{CBO}

With dc collector volts

= -2, dc emitter current = 0. - -100 - μ a

With dc collector volts

= -40, dc emitter current = 0. - -2 -4 ma

With dc collector volts

= -40, dc emitter current = 0, case

temperature^b = 71° C. - - -15 ma

DC Current Transfer Ratio h_{FE}

for dc collector-to-

emitter volts = -2, dc collector amperes =

-5. 35 - 70

-12. - 25 -

→ Indicates a change.



Beta-Cutoff Frequency for dc collector-to-emitter volts = -6, dc collector amperes = -5.	f_{ae}	-	10	-	kc
Thermal Resistance: Junction-to-case.	R_T	-	0.35	0.5	$^{\circ}\text{C}/\text{watt}$
Thermal Capacity for pulse duration of 1 to 10 milliseconds.		-	0.075	-	$\text{watt-sec}/^{\circ}\text{C}$
Thermal Time Constant	τ_1	-	26.25	-	msec

- b Measured at any point on seating surface.
c Tested by sweep method to prevent excessive heating of collector junction.

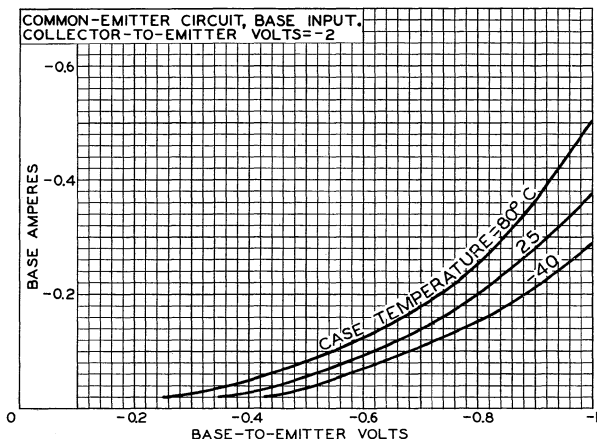
**PERFORMANCE TESTS,
OPERATING CONSIDERATIONS,
DIMENSIONAL OUTLINE,
SUGGESTED MOUNTING ARRANGEMENT,
and**

RATING CHART

shown under Type 2N173 also apply to the 2N277

← Indicates a change.

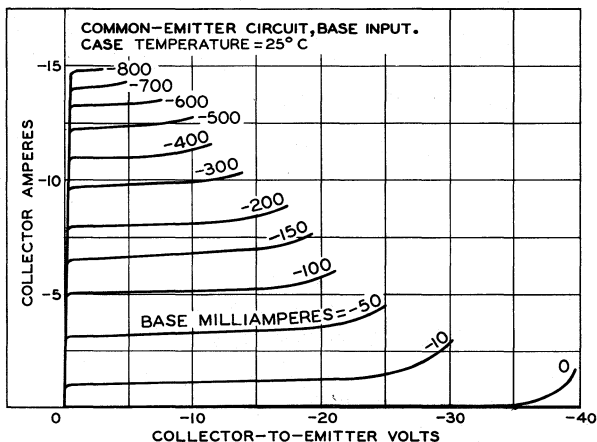
TYPICAL BASE CHARACTERISTICS



92CS-10703

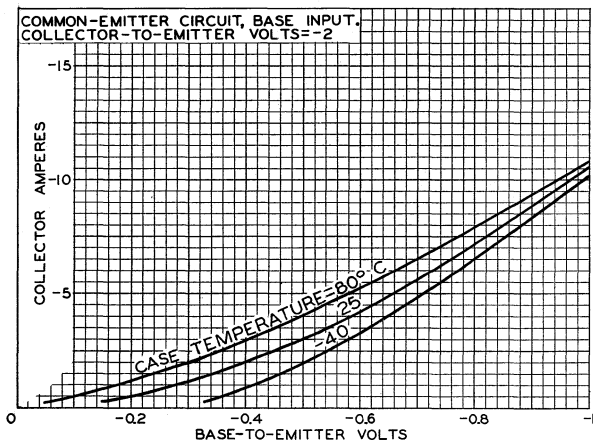


TYPICAL COLLECTOR CHARACTERISTICS



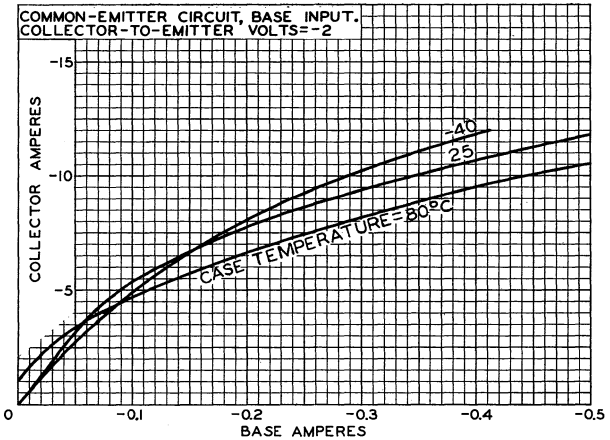
92CS-10725

TYPICAL CHARACTERISTICS



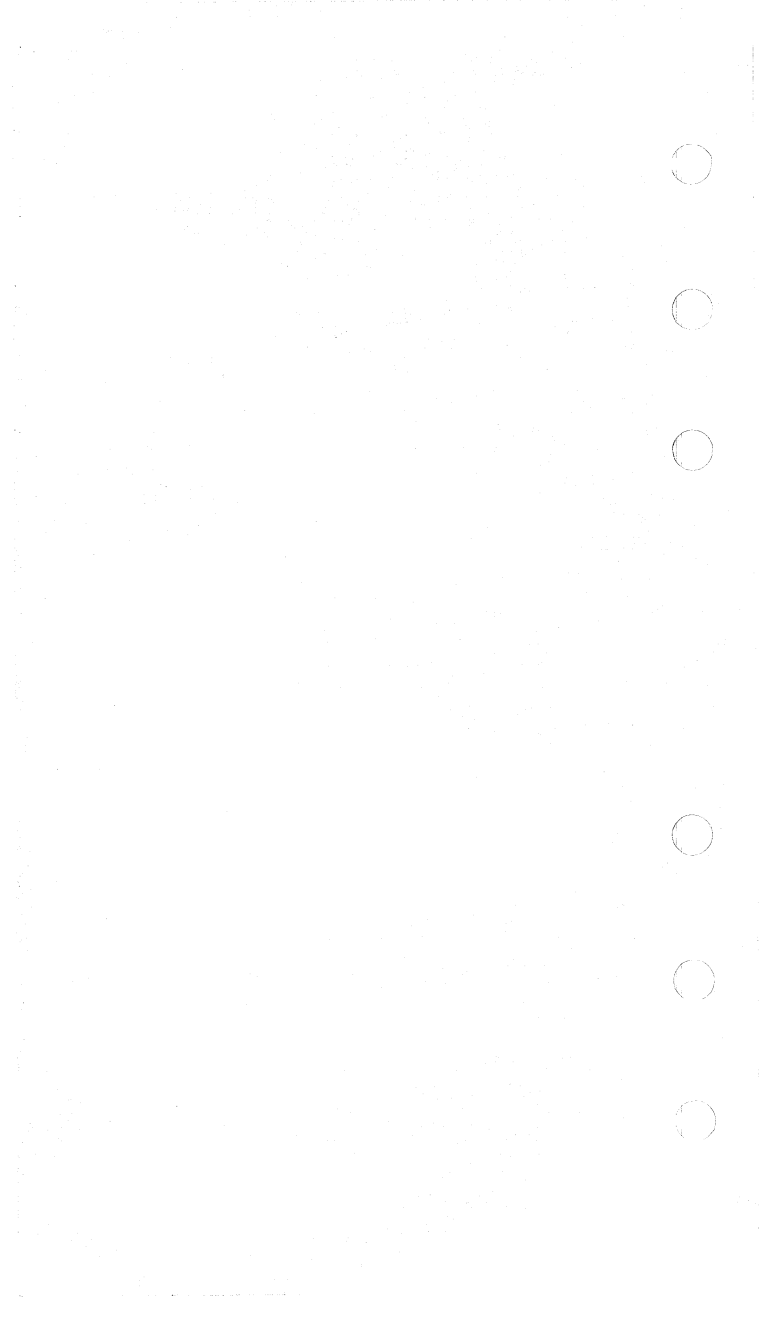
92CS-10709

TYPICAL CHARACTERISTICS



92CS-10712





Power Transistor

GERMANIUM P-N-P ALLOY TYPE

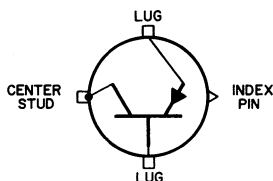
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position. Any
Maximum Seated Length 0.520"
Maximum Diameter. 1.250"
Dimensional Outline JEDEC No. TO-36
Case. Welded, Metal
Seals Hermetic
Terminal Diagram (See *Dimensional Outline*):

BOTTOM VIEW



INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and audio-
amplifier, relay- and solenoid-actuating circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter-to-base reverse biased

(DC emitter-to-base volts = 1.5). -50 max. volts
EMITTER-TO-BASE VOLTAGE -30 max. volts
COLLECTOR CURRENT -15 max. amp
EMITTER CURRENT 15 max. amp
BASE CURRENT. -4 max. amp

TRANSISTOR DISSIPATION:^a

At case temperatures^b of 25° C or below 150 max. watts

CASE-TEMPERATURE^b RANGE:

Operating and storage -65 to +100 °C

Typical Operation:

In a common-emitter, base-input, power-switching
circuit at case temperature^b of 25° C

DC Supply Voltage -12 volts
DC Base-Bias Voltage. 6 volts
"On" DC Collector Current -12 amp
"Turn-On" Base Current. -2 amp
"Turn-Off" Base Current 0 amp

← Indicates a change.



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DATA 1
8-61

Switching Time:

Rise time	15	μ sec
Fall time	15	μ sec

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in *General Section*.

^b Measured at any point on seating surface.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25° C unless otherwise specified
Min. Typical Max.

DC Collector-to-Emitter

Breakdown Voltage:

With base connected to emitter, dc collector

amperes = -0.3	BV_{CES}	-45	-	-	volts
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With base open:

For dc collector

amperes = -0.3	BV_{CEO}	-	-45	-	volts
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For dc collector

amperes = -1 ^c		-30	-	-	volts
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DC Base-to-Emitter

Voltage for dc collector-to-emitter volts

= -2, dc collector amperes = -5	V_{BE}	-	-0.65	-	volt
---	----------	---	-------	---	------

DC Collector-to-Emitter

Saturation Voltage for

dc collector amperes

= -12, dc base amperes

= -2	$V_{CE(sat)}$	-	-0.3	-0.7	volt
----------------	---------------	---	------	------	------

DC Emitter Voltage for

dc collector volts =

-50, dc emitter current

= 0	V_{EB}	-	-	-1	volt
---------------	----------	---	---	----	------

DC Punch-Through Voltage

V_{PT}	-50	-	-	-	volts
----------	-----	---	---	---	-------

DC Emitter-Cutoff Current

for dc emitter volts =

-30, dc collector

current = 0	I_{EBO}	-	-1	-4	ma
-----------------------	-----------	---	----	----	----

DC Collector-Cutoff

Current:

With dc collector volts

= -2, dc emitter

current = 0	I_{CBO}	-	-100	-	μ a
-----------------------	-----------	---	------	---	---------

With dc collector volts

= -50, dc emitter

current = 0		-	-2	-4	ma
-----------------------	--	---	----	----	----

With dc collector volts

= -50, dc emitter

current = 0, case temperature ^b = 71° C		-	-	-15	ma
--	--	---	---	-----	----

→ indicates a change.



DC Current Transfer Ratio h_{FE} for dc collector-to-emitter volts = -2, dc collector amperes =				
-5	35	-	70	
-12	-	25	-	
Beta-Cutoff Frequency for dc collector-to-emitter volts = -6, dc collector amperes = -5	f_{ae}	-	10	- kc
Thermal Resistance: Junction-to-case	R_T	-	0.35	0.5 °C/watt
Thermal Capacity for pulse duration of 1 to 10 milliseconds		-	0.075	- watt-sec/°C msec
Thermal Time Constant	τ_1	-	52.5	- msec

^b Measured at any point on seating surface.

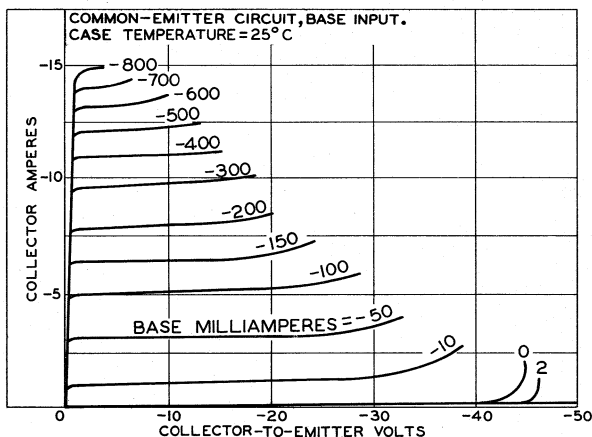
^c Tested by sweep method to prevent excessive heating of collector junction.

PERFORMANCE TESTS,
OPERATING CONSIDERATIONS,
DIMENSIONAL OUTLINE,
SUGGESTED MOUNTING ARRANGEMENT,
RATING CHART,
TYPICAL BASE-CHARACTERISTICS CURVES,
and
TYPICAL CHARACTERISTICS CURVES
 shown under Type 2N173 also apply to the 2N278

← Indicates a change.



TYPICAL COLLECTOR CHARACTERISTICS



92CS-10738





2N351

POWER TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For audio-frequency power applications

2N351

GENERAL DATA

Electrical:

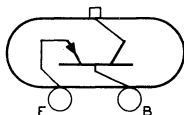
Minimum DC Collector-to-Emitter Voltage (V_{CE}) for dc collector ma. = -330 with base connected to emitter, and for mounting-flange temperature of 25° C.	-30	volts
Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = -30 with emitter open, and for mounting-flange temperature of 25° C.	-3	ma
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = -10 with collector open, and for mounting-flange temperature of 25° C.	-2	ma
Junction-Temperature Rise (In free air)	1	°C/watt

Mechanical:

Operating Position.	Any
Maximum Overall Length.	0.80"
Maximum Seated Length.	0.41"
Maximum Length of Mounting Flange.	1.562"
Maximum Width of Mounting Flange.	1.12"
Case.	Metal
Mounting Flange.	Metal
Envelope Seals.	Hermetic
Terminal Connections (See Dimensional Outline):	

E - Emitter

B - Base



MOUNTING FLANGE-Collector

AUDIO-FREQUENCY POWER AMPLIFIER — Class A

Maximum Ratings, Absolute Values:

PEAK COLLECTOR-TO-BASE VOLTAGE.	-40 max.	volts
PEAK COLLECTOR CURRENT.	-3 max.	amp
PEAK EMITTER CURRENT.	3 max.	amp
TRANSISTOR DISSIPATION:*		
For mounting-flange temperature of 80° C	10 max.	watts
MOUNTING-FLANGE TEMPERATURE (During operation).	90 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +90	°C

*: See next page.



2N351

POWER TRANSISTOR

Characteristics, For Mounting-Flange Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage.	-2	volts
DC Collector Current	-0.7	amp
Small-Signal Input Resistance	13	ohms
Small-Signal Current Transfer Ratio*	-45	
Large-Signal DC Current Transfer Ratio.	65	

Typical Operation, For Mounting-Flange Temperature of 80° C:*Common-Emitter Circuit, Base Input*

DC Supply Voltage.	-14.4	volts
DC Collector-to-Emitter Voltage.	-13.2	volts
Emitter Resistor	1	ohm
DC Base-to-Emitter Voltage	-0.3	volt
DC Collector Current:		
Peak	-1.4	amp
Zero-Signal.	-0.7	amp
Zero-Signal Collector Dissipation.	9.25	watts
Signal-Source Impedance.	10	ohms
Load Impedance	15	ohms
Signal Frequency	1	kc
Power Gain	33.5	db
Total Harmonic Distortion.	5	%
Max.-Signal Power Output	4	watts

AUDIO-FREQUENCY POWER AMPLIFIER — Class B**Maximum Ratings, Absolute Values:**

PEAK COLLECTOR-TO-BASE VOLTAGE	-40 max.	volts
PEAK COLLECTOR CURRENT	-3 max.	amp
PEAK EMITTER CURRENT	3 max.	amp
TRANSISTOR DISSIPATION:*		
For mounting-flange temperature of 80° C.	10 max.	watts
MOUNTING-FLANGE TEMPERATURE (During operation)	90 max.	°C
STORAGE-TEMPERATURE RANGE.	-65 to +90	°C

* The maximum transistor-dissipation rating is reduced 1 watt for each degree centigrade the mounting-flange temperature is increased above 80° C.

• Measured at a signal frequency of 1 kc.

OPERATING CONSIDERATIONS

The base and emitter pins of the 2N351 fit the Loranger Mfg. Corp. Socket No. 2149, or equivalent. When a socket is not used, connections can be soldered directly to the base and emitter pins. Soldering of the connections to the pins may be made close to the pin seals provided care is taken to



2N351

2N351

POWER TRANSISTOR

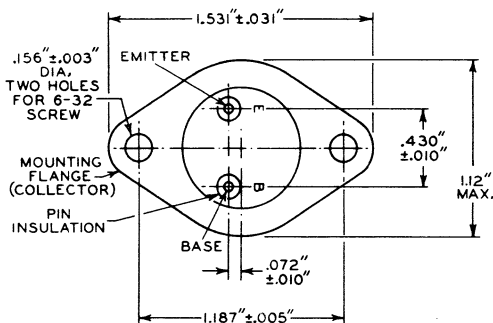
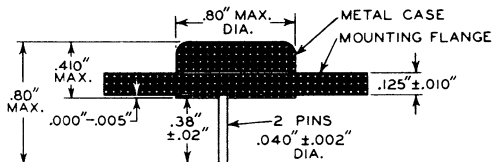
conduct excessive heat away from the pin seals. Otherwise, the heat of the soldering operation will crack the glass seals of the pins and damage the transistor.

It is important that the mounting flange which serves as the collector for the 2N351 be securely fastened to a heat sink. Depending on the application, the chassis (heat sink) may be connected either to the positive or negative terminal of the voltage supply.

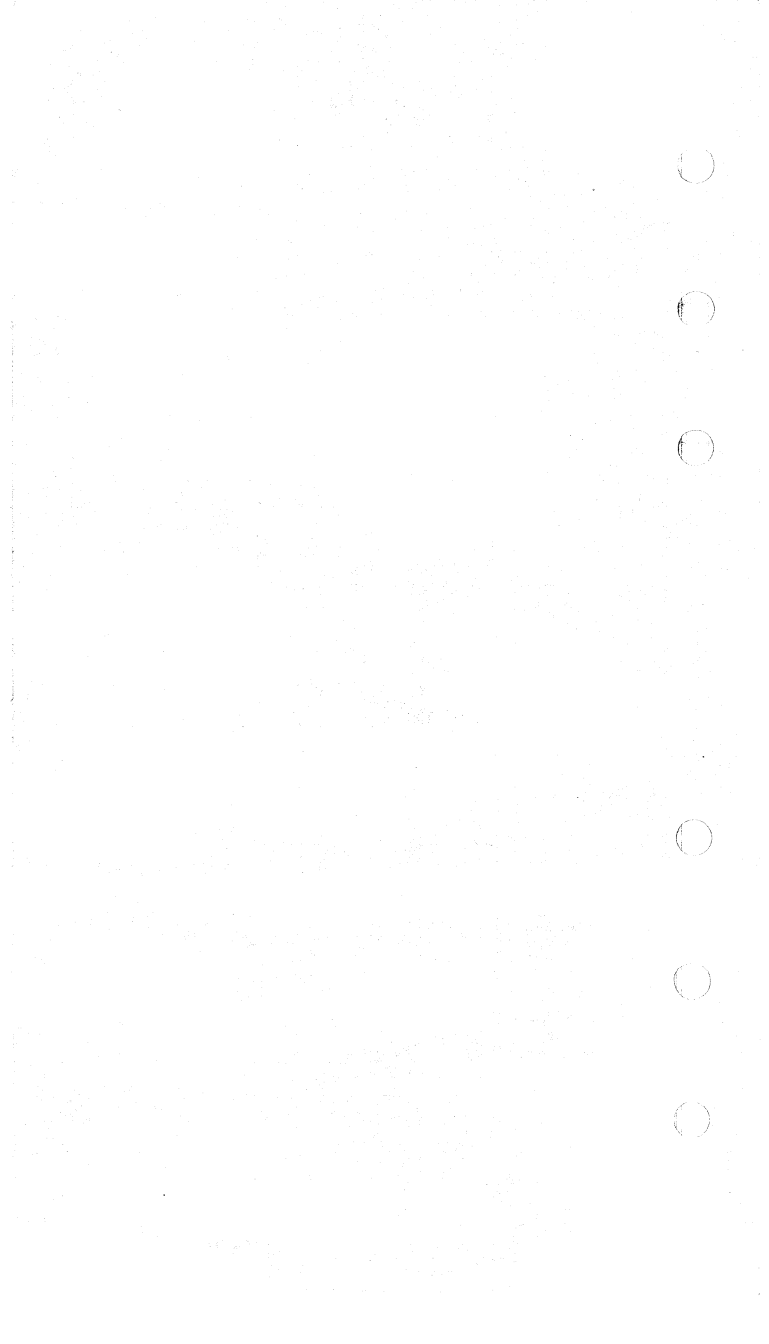
It is to be noted that the metal shell of the 2N351 operates at the collector voltage. Consideration, therefore, should be given to the possibility of shock hazard if the metal shell of this transistor is to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

Under no circumstances should the mounting flange be soldered to the heat sink because the heat of the soldering operation will permanently damage the transistor.

The 2N351 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.



92CS-9624





2N370

2N370

DRIFT TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For radio-frequency amplifier applications

GENERAL DATA

Electrical:

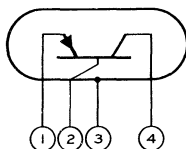
Maximum DC Collector Current for dc collector-to-base voltage of -12 volts with emitter open, and at ambient temperature of 25° C.	-20	μa
Maximum DC Emitter Current for dc emitter-to-base voltage of -1.5 volts with collector open, and at ambient temperature of 25° C.	-50	μa
Interlead Capacitance between collector and base leads with interlead shield connected to ground and all leads cut to 5/16"	0.003	μμf

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.375"
Maximum Diameter.	0.360"
Case.	Metal
Envelope Seals.	Hermetic
Leads, Flexible	4
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Interlead
Shield,
Metal
Case
Lead 4 - Collector

RADIO-FREQUENCY AMPLIFIER — Class A

Maximum Ratings, Absolute Values:

DC COLLECTOR-TO-BASE VOLTAGE.	-20 max.	volts
DC EMITTER-TO-BASE VOLTAGE.	-1.5 max.	volts
DC COLLECTOR CURRENT.	-10 max.	ma
DC EMITTER CURRENT.	10 max.	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C	80 max.	mw
At ambient temperature of 55° C	40 max.	mw
At ambient temperature of 71° C	20 max.	mw
AMBIENT TEMPERATURE (During operation).	71 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C



2N370

DRIFT TRANSISTOR

Characteristics, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage.	-12	volts
DC Emitter Current	1	ma
Current Transfer Ratio (α_f) [■]	-60	
Frequency for unity power amplification.	132	Mc

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-12	volts
DC Emitter Current	1	ma
Current Transfer Ratio (α_f) [■]	0.984	
Frequency at which the current transfer ratio drops to 0.707 times its value at 1 kc.	30	Mc

Typical Operation, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

At frequency of	1.5	10	20	Mc
DC Collector-to-Emitter Voltage.	-12	-12	-12	volts
DC Emitter Current	1	1	1	ma
Input Resistance	1750	200	100	ohms
Output Resistance.	180000	18000	11000	ohms
Maximum Power Gain [▲]	50.5	26.2	17	db
Maximum Useful Power Gain (In an unneutralized circuit).	31	17.6	12.5	db
Intrinsic Transconductance	37800	21400	13700	μ mhos
Collector Transition Capacitance	1.7	1.7	1.7	μ mf

■ Measured at 1 kc.

▲ Measured in a single-tuned unilateralized circuit matched to the generator and load impedances for maximum transfer of power. Transformer insertion losses not included.

OPERATING CONSIDERATIONS

The 2N370 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N370 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise the heat of the soldering operation will crack the seals of the leads and damage the transistor.

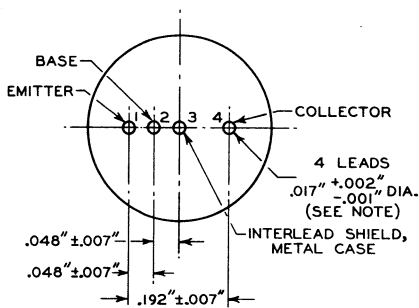
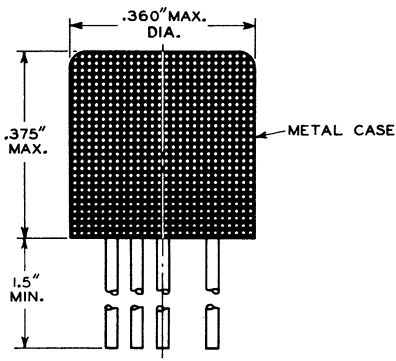
When dip soldering is employed in the assembly of printed circuitry using the 2N370, the temperature of the solder should not exceed 230° C for a maximum immersion period of 10 seconds.



2N370

2N370

DRIFT TRANSISTOR



92CS-9122R3

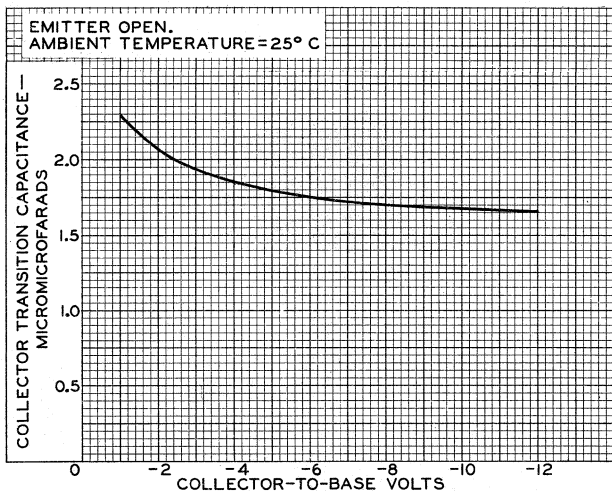
NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

2N370



2N370

AVERAGE CHARACTERISTIC



92CS-9527

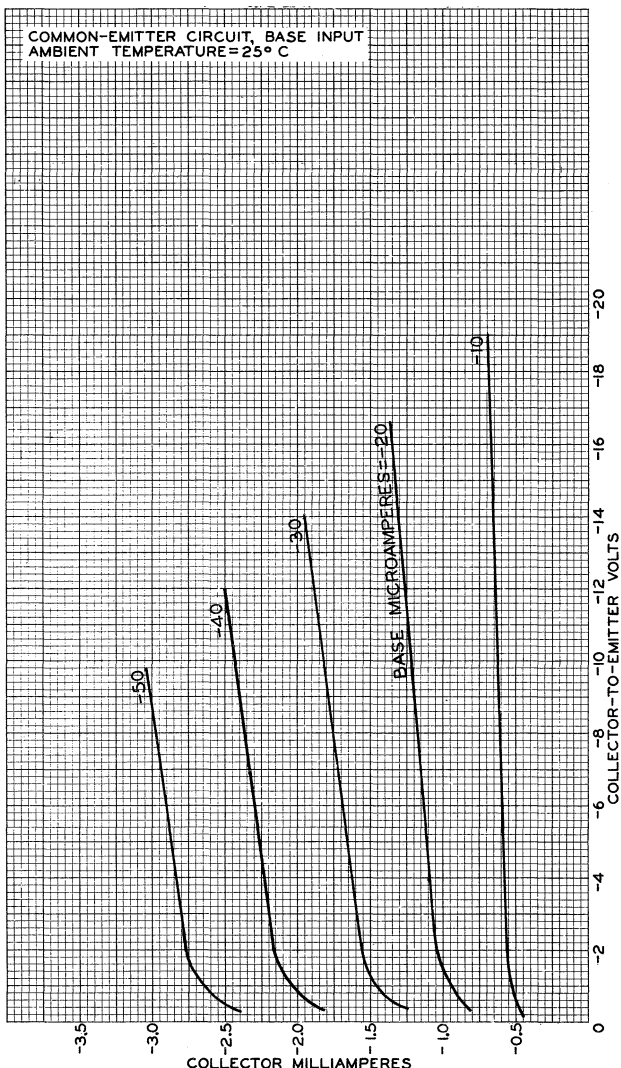


2N370

2N370

AVERAGE COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT
AMBIENT TEMPERATURE = 25° C

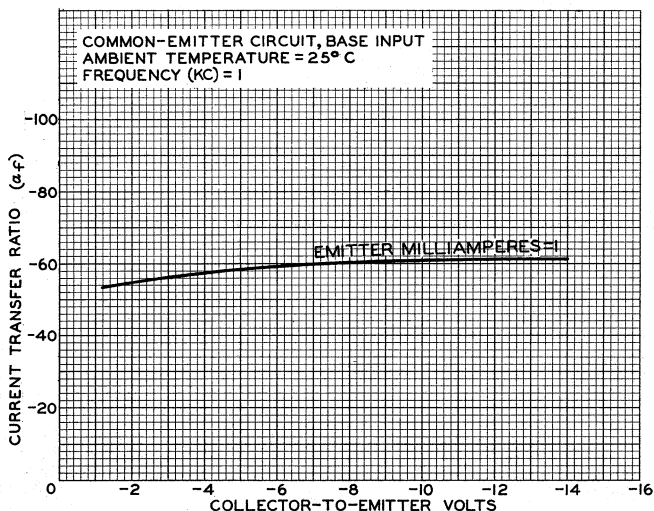
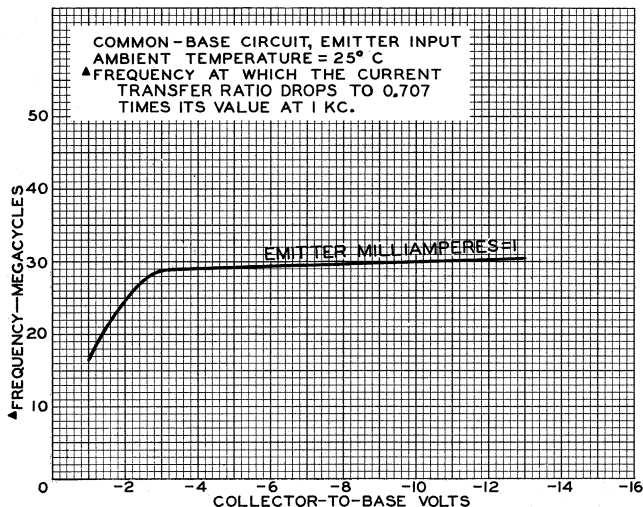


2N370



2N370

AVERAGE CHARACTERISTICS





2N371

2N371

DRIFT TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For radio-frequency oscillator applications

GENERAL DATA

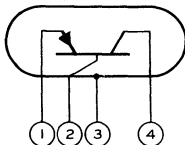
Electrical:

Maximum DC Collector Current for dc collector-to-base voltage of -12 volts with emitter open, and at ambient temperature of 25° C	-20	μ a
Maximum DC Emitter Current for dc emitter-to-base voltage of -0.5 volt with collector open, and at ambient temperature of 25° C	-50	μ a
Interlead Capacitance between collector and base leads with interlead shield connected to ground and all leads cut to 5/16"	0.003	μ mf

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.375"
Maximum Diameter.	0.360"
Case.	Metal
Envelope Seals.	Hermetic
Leads, Flexible	4
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline

Lead 1 - Emitter



Lead 2 - Base

Lead 3 - Interlead
Shield,
Metal
Case
Lead 4 - Collector

RADIO-FREQUENCY OSCILLATOR

Maximum Ratings, Absolute Values:

DC COLLECTOR-TO-BASE VOLTAGE.	-20 max.	volts
DC EMITTER-TO-BASE VOLTAGE.	-0.5 max.	volt
DC COLLECTOR CURRENT.	-10 max.	ma
DC EMITTER CURRENT.	10 max	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C	80 max.	mw
At ambient temperature of 55° C	40 max.	mw
At ambient temperature of 71° C	20 max.	mw
AMBIENT TEMPERATURE (During operation).	71 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C



2N371

DRIFT TRANSISTOR

Characteristics, At Ambient Temperature of 25° C:

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage.	-12	volts
DC Emitter Current.	1	ma
Current Transfer Ratio (α_f) [■]	0.984	
Frequency at which the current transfer ratio drops to 0.707 times its value at 1 kc	30	Mc

Typical Operation:

The 2N371 can produce an oscillator-injection voltage which will provide optimum mixing in a typical rf tuner circuit.

In an oscillator stage utilizing the 2N371 and operating at 22 Mc, if the collector-supply voltage drops from -12 to -8 volts, the frequency provided by this stage will deviate from 22 Mc by less than 7 kc.

■ Measured at 1 kc.

OPERATING CONSIDERATIONS

The 2N371 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N371 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N371, the temperature of the solder should not exceed 230° C for a maximum immersion period of 10 seconds.

DIMENSIONAL OUTLINE and CURVES
shown for Type 2N370 also apply to the 2N371



2N372

2N372

DRIFT TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For radio-frequency mixer applications

GENERAL DATA

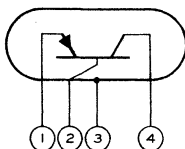
Electrical:

Maximum DC Collector Current for dc collector-to-base voltage of -12 volts with emitter open, and at ambient temperature of 25° C	-20	μa
Maximum DC Emitter Current for dc emitter-to-base voltage of -0.5 volt with collector open, and at ambient temperature of 25° C	-50	μa
Interlead Capacitance between collector and base leads with interlead shield connected to ground and all leads cut to 5/16"	0.003	μμf

Mechanical:

Operating Position	Any
Maximum Length (Excluding flexible leads)	0.375"
Maximum Diameter	0.360"
Case	Metal
Envelope Seals	Hermetic
Leads, Flexible	4
Minimum length	1.5"
Orientation and diameter	See Dimensional Outline

Lead 1 - Emitter

Lead 3 - Interlead
Shield,
Metal
Case

Lead 2 - Base

Lead 4 - Collector

RADIO-FREQUENCY MIXER

Maximum Ratings, Absolute Values:

DC COLLECTOR-TO-BASE VOLTAGE	-20 max.	volts
DC EMITTER-TO-BASE VOLTAGE	-0.5 max.	volt
DC COLLECTOR CURRENT	-10 max.	ma
DC EMITTER CURRENT	10 max.	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C	80 max.	mw
At ambient temperature of 55° C	40 max.	mw
At ambient temperature of 71° C	20 max.	mw
AMBIENT TEMPERATURE (During operation)	71 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C



2N372

DRIFT TRANSISTOR

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage	-12	volts
DC Emitter Current	1	ma
Current Transfer Ratio (α_f) [■]	-60	
Frequency for unity power amplification. .	132	Mc

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-12	volts
DC Emitter Current	1	ma
Current Transfer Ratio (α_f) [■]	0.984	
Frequency at which the current transfer ratio drops to 0.707 times its value at 1 kc.	30	Mc

Typical Operation, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

At frequency of	1.5	10	20	Mc
DC Collector-to-Emitter Voltage.	-12	-12	-12	volts
DC Emitter Current	1	1	1	ma
Input Resistance	1750	200	100	ohms
Output Resistance.	180000	18000	11000	ohms
Maximum Power Gain [▲]	50.5	26.2	17	db
Maximum Useful Power Gain (In an unneutralized circuit).	31	17.6	12.5	db
Intrinsic Transconductance . . .	37800	21400	13700	μ mhos
Collector Transition Capacitance.	1.7	1.7	1.7	μ mf

■ Measured at 1 kc.

▲ Measured in a single-tuned unilateralized circuit matched to the generator and load impedances for maximum transfer of power. Transformer insertion losses not included.

OPERATING CONSIDERATIONS

The 2N372 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N372 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N372, the temperature of the solder should not exceed 230° C for a maximum immersion period of 10 seconds.

DIMENSIONAL OUTLINE and CURVES
shown for Type 2N372 also apply to the 2N372



2N376

2N376

POWER TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For audio-frequency power applications

GENERAL DATA

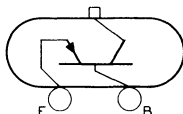
Electrical:

Minimum DC Collector-to-Emitter Voltage (BV_{CE}) for dc collector ma. = -330 with base connected to emitter, and for mounting-flange temperature of 25° C. . .	-30	volts
Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = -30 with emitter open, and for mounting-flange temperature of 25° C. . .	-3	ma
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = -10 with collector open, and for mounting-flange temperature of 25° C. . .	-2	ma
Junction-Temperature Rise (In free air) . .	1	°C/watt

Mechanical:

Operating Position.	Any
Maximum Overall Length.	0.80"
Maximum Seated Length.	0.41"
Maximum Length of Mounting Flange.	1.562"
Maximum Width of Mounting Flange.	1.12"
Case.	Metal
Mounting Flange.	Metal
Envelope Seals.	Hermetic
Terminal Connections (See Dimensional Outline):	

E - Emitter

MOUNTING FLANGE-
Collector

B - Base

AUDIO-FREQUENCY POWER AMPLIFIER — Class A

Maximum Ratings, Absolute Values:

PEAK COLLECTOR-TO-BASE VOLTAGE.	-40 max.	volts
PEAK COLLECTOR CURRENT.	-3 max.	amp
PEAK EMITTER CURRENT.	3 max.	amp
TRANSISTOR DISSIPATION:*		
For mounting-flange temperature of 80° C .	10 max.	watts
MOUNTING-FLANGE TEMPERATURE (During operation).	90 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +90	°C

*: See next page.



2N376

POWER TRANSISTOR

Characteristics, For Mounting-Flange Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage	-2	volts
DC Collector Current	-0.7	amp
Small-Signal Input Resistance	16	ohms
Small-Signal Current Transfer Ratio	-60	
Large-Signal DC Current Transfer Ratio	78	

Typical Operation, For Mounting-Flange Temperature of 80° C:*Common-Emitter Circuit, Base Input*

DC Supply Voltage	-14.4	volts
DC Collector-to-Emitter Voltage	-13.2	volts
Emitter Resistor	1	ohm
DC Base-to-Emitter Voltage	-0.3	volt
DC Collector Current:		
Peak	-1.4	amp
Zero-Signal	-0.7	amp
Zero-Signal Collector Dissipation	9.25	watts
Signal-Source Impedance	10	ohms
Load Impedance	15	ohms
Signal Frequency	1	kc
Power Gain	35	db
Total Harmonic Distortion	5	%
Max.-Signal Power Output	4	watts

AUDIO-FREQUENCY POWER AMPLIFIER — Class B**Maximum Ratings, Absolute Values:**

PEAK COLLECTOR-TO-BASE VOLTAGE	-40 max.	volts
PEAK COLLECTOR CURRENT	-3 max.	amp
PEAK EMITTER CURRENT	3 max.	amp
TRANSISTOR DISSIPATION:		
For mounting-flange temperature of 80° C.	10 max.	watts
MOUNTING-FLANGE TEMPERATURE (During operation)	90 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +90	°C

* The maximum transistor-dissipation rating is reduced 1 watt for each degree centigrade the mounting-flange temperature is increased above 80° C.

• Measured at a signal frequency of 1 kc.

OPERATING CONSIDERATIONS

The *base and emitter pins* of the 2N376 fit the Loranger Mfg. Corp. Socket No. 2149, or equivalent. When a socket is not used, connections can be soldered directly to the base and emitter pins. Soldering of the connections to the pins may be made close to the pin seals provided care is taken to conduct excessive heat away from the pin seals. Otherwise, the heat of the soldering operation will crack the glass seals of the pins and damage the transistor.

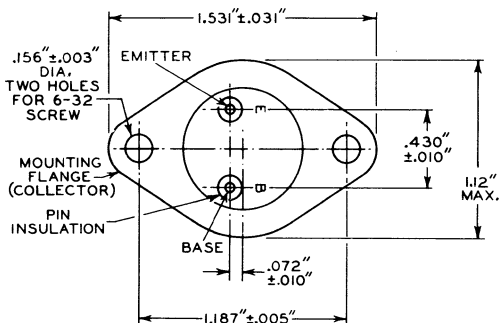
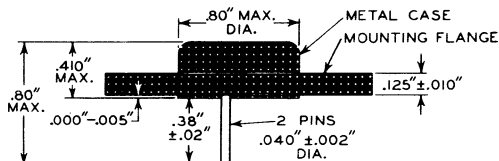
POWER TRANSISTOR

It is important that the mounting flange which serves as the collector for the 2N376 be securely fastened to a heat sink. Depending on the application, the chassis (heat sink) may be connected either to the positive or negative terminal of the voltage supply.

It is to be noted that the metal shell of the 2N376 operates at the collector voltage. Consideration, therefore, should be given to the possibility of shock hazard if the metal shell of this transistor is to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

Under no circumstances should the mounting flange be soldered to the heat sink because the heat of the soldering operation will permanently damage the transistor.

The 2N376 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.



92CS-9624



Drift-Field Transistor

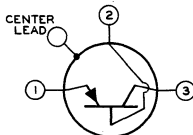
GERMANIUM P-N-P ALLOY TYPE
For Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.405"
Maximum Diameter.	0.240"
Dimensional Outline	JEDEC No. TO-44
Case.	Metal
Seals	Hermetic
Leads, Flexible	4
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1—Emitter
Center Lead—
Interlead
Shield,
Case



Lead 2—Base
Lead 3—Collector
(Adjacent
to red dot
on side of
case)

INDUSTRIAL SERVICE

Such as in rf, if, oscillator, mixer, converter, and low-level video-amplifier circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE (Emitter open). . .	-40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE (Base-to-emitter volts = 0.5)	-40 max.	volts
EMITTER-TO-BASE VOLTAGE	-0.5 max.	volt
COLLECTOR CURRENT	-10 max.	ma
EMITTER CURRENT	10 max.	ma
TRANSISTOR DISSIPATION: ^a		
At ambient temperature of 25° C		
for operation in free air	120 max.	mw
At case temperature of 25° C		
for operation with heat sink.	240 max.	mw
AMBIENT-TEMPERATURE RANGE:		
Operating and storage	-65 to +100	°C

Typical Operation:

*In accompanying video-amplifier circuit with
ambient temperature range of -65 to +55° C*

DC Collector-to-Emitter Voltage	-12	volts
DC Emitter Current.	5.8	ma
Source Impedance.	150	ohms
Capacitive Load	16	μmf



RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division Somerville, N. J.

DATA 1
6-61

Frequency-Response Range:

Minimum.	20	cps
Maximum.	10	Mc
Pulse-Rise Time.	0.035	μ sec
Voltage Gain	26	db
Maximum Peak-to-Peak Output Voltage.	20	volts

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base unless otherwise specified. Ambient temperature = 25° C.

Min. Typical Max.

DC Collector Breakdown					
Voltage for dc collector					
μ a = -50, dc emitter					
ma. = 0. BV _{CBO}					
	-40	-80	-		volts
Punch-Through Voltage for					
dc emitter volts = -0.5. . V _P					
	-40	-80	-		volts
DC Collector-Cutoff Current					
for dc collector volts =					
-12, dc emitter ma. = 0. . I _{CBO}					
	-	-4	-12		μ a
DC Emitter-Cutoff Current					
for dc emitter volts =					
-0.5, collector open . . I _{EBO}					
	-	-1	-12		μ a
Small-Signal Current Trans-					
fer Ratio for dc collec-					
tor-to-emitter volts =					
-12, dc emitter ma. = 1.5,					
signal frequency of 1 kc. h _{fe}					
	20	60	175		
→ Alpha-Cutoff Frequency for					
dc collector volts = -12,					
dc emitter ma. = 1.5 . . f _{ab}					
	-	100	-		Mc
Input Resistance: ^b R _{in}					
With dc collector volts					
= -12, dc emitter ma. =					
1.5, signal frequency					
of 50 Mc.					
	-	30	-		ohms
With dc collector-to-					
emitter volts = -12, dc					
emitter ma. = 1.5, sig-					
nal frequency of 30 Mc. .					
	-	50	-		ohms
With dc collector-to-					
emitter volts = -12, dc					
emitter ma. = 1.5, sig-					
nal frequency of 12.5 Mc. .					
	-	250	-		ohms
Output Resistance: ^c R _{out}					
With dc collector volts					
= -12, dc emitter ma.					
= 1.5, signal fre-					
quency of 50 Mc.					
	-	5000	-		ohms

→ Indicates a change.



With dc collector-to-emitter volts = -12, dc emitter ma. = 1.5, signal frequency of 30 Mc.	-	5000	-	ohms
With dc collector-to-emitter volts = -12, dc emitter ma. = 1.5, signal frequency of 12.5 Mc.	-	16000	-	ohms
Collector-to-Base Capacitance for dc collector volts = -12, dc emitter ma. = 0.	-	2	3	μmf
Power Gain: ^d C_{ob} PG				
With dc collector volts = -12, dc emitter ma. = 1.5, signal frequency of 50 Mc. . . .	15	18	21	db
With dc collector-to-emitter volts = -12, dc emitter ma. = 1.5, signal frequency of 30 Mc.	16	20	24	db
With dc collector-to-emitter volts = -12, dc emitter ma. = 1.5, signal frequency of 12.5 Mc.	24	28	32	db
Thermal Resistance: R_T				
Between junction and case	-	-	0.31	$^{\circ}\text{C/watt}$
Between junction and free air	-	-	0.62	$^{\circ}\text{C/watt}$

b AC output-circuit shorted.
c AC input-circuit shorted.

d Measured in a single-tuned unilateralized circuit matched to the generator and load impedance for maximum transfer of power (transformer-insertion losses not included).

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.

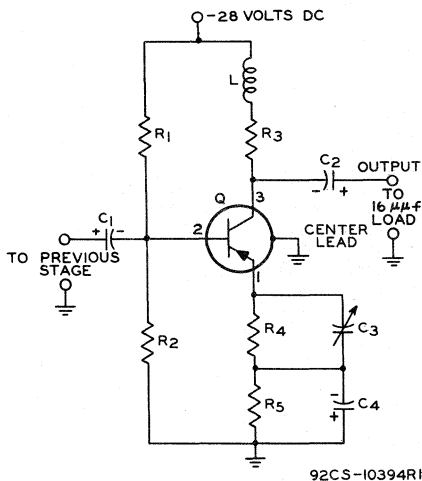


2N384

When dip soldering is employed in the assembly of printed circuitry using this transistor, the temperature of the solder should not exceed 255°C for a maximum immersion period of 10 seconds.

This transistor utilizes shielding to minimize interlead capacitance and coupling to adjacent circuit components. This shielding is provided by a fourth lead which is internally connected to the case. For optimum performance, it is recommended that this lead be connected to the chassis ground.

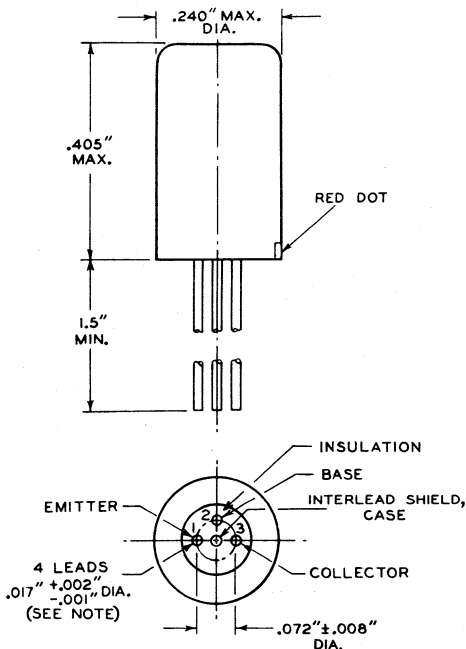
VIDEO-AMPLIFIER CIRCUIT



- C_1 : 25 μf , 12 volts
- C_2 : 25 μf , 25 volts
- C_3 : 100 to 300 μf (variable)
- C_4 : 100 μf , 12 volts
- L : 30 μh
- Q : Transistor type 2N384
- R_1 : 20,000 ohms, 0.25 watt
- R_2 : 3600 ohms, 0.25 watt
- R_3 : 2000 ohms, 0.25 watt
- R_4 : 62 ohms, 0.25 watt
- R_5 : 620 ohms, 0.25 watt

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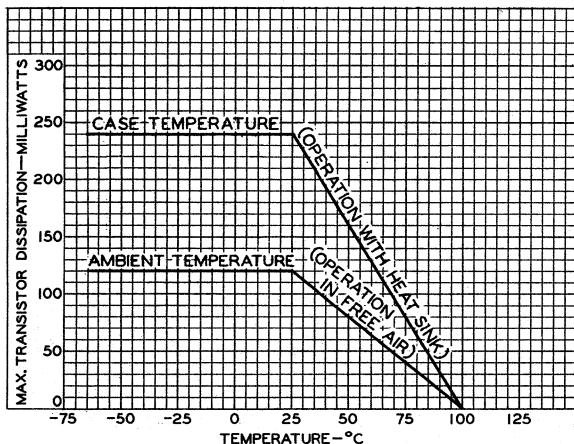


92CS-9266R2

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE PLANE OF THE ACTUAL BOTTOM OF THE CASE. BETWEEN 0.250" AND 1.50", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

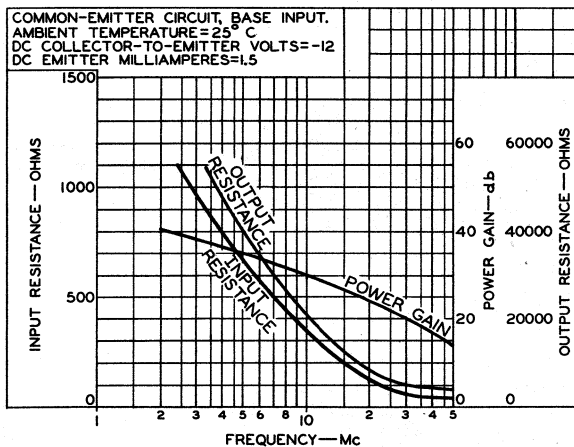


RATING CHART



92CS-1038IRI

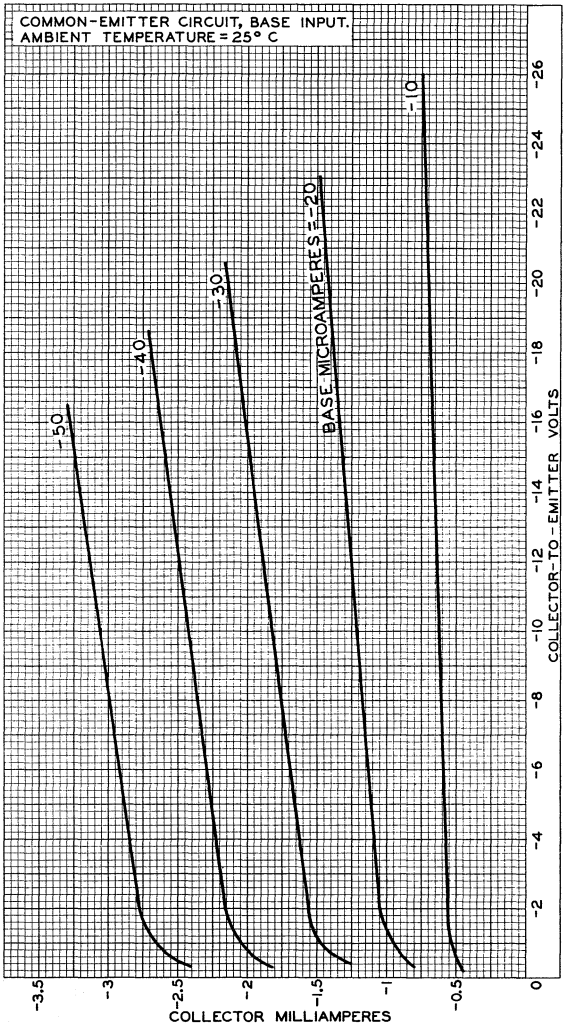
PERFORMANCE CHARACTERISTICS



92CS-10396



TYPICAL COLLECTOR CHARACTERISTICS



92CM-9418



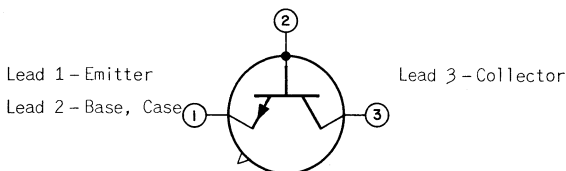
Transistor

GERMANIUM N-P-N ALLOY-JUNCTION TYPE
For Switching Applications in Commercial
and Military Data-Processing Equipment

GENERAL DATA

Mechanical:

Dimensions. See Outline TO-5 in General Section
Terminal Diagram: BOTTOM VIEW



SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CBO} 25 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With external resistance between
base and emitter (ohms) = 10000. . . V_{CER} 20 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EBO} 15 max. volts

COLLECTOR CURRENT. I_C 200 max. ma

TRANSISTOR DISSIPATION:^a

At free-air temperature of 25° C
or below P 150 max. mw

TEMPERATURE RANGE:

Storage. T_{stg} -65 to +100 °C

Operating (Junction) T_J 100 max. °C

LEAD TEMPERATURE:

For 10 seconds maximum^b. T_L 235 max. °C

^a See accompanying Rating Chart.

^b Measured 1/16" ± 1/32" down from seating plane.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless
otherwise specified. Free-air temperature of 25° C.

Min. Max.

DC Base-to-Emitter Voltage:

V_{BE}

With dc collector ma. = 200,
dc base ma. = 10 - 1.5 volts

With dc collector ma. = 100,
dc base ma. = 4. - 0.8 volt



Min. Max.

DC Collector Current for dc collector-to-emitter volts = 20, external resistance between base and emitter (ohms) = 10000.	I_{CER}	-	50	μa
DC Collector-Cutoff Current for dc emitter ma. = 0, dc collector volts =	I_{CBO}	-		
25.		-	10	μa
1.		-	5	μa
DC Emitter-Cutoff Current for dc collector ma. = 0, dc emitter volts =	I_{EBO}	-		
15.		-	10	μa
1.		-	5	μa
Collector-to-Base Capacitance for dc collector volts = 6, dc collector ma. = 1.	C_{ob}	-	20	pf
DC Forward-Current Transfer Ratio:	h_{FE}			
With dc collector-to-emitter volts = 0.75, dc collector ma. = 200.		30	-	
With dc collector-to-emitter volts = 0.50, dc collector ma. = 30.		60	180	
Alpha-Cutoff Frequency for dc collector volts = 6, dc collector ma. = 1.	f_{ab}	5	-	Mc
Switching Time for dc collector supply volts = 20, collector resistance (ohms) = 100, turn-on dc base ma. = 10, turn-off dc base ma. = -10, dc collector ma. = 200:				
Turn-on time (Delay time + rise time).	t_{on}	-	1	μsec
Storage time.	t_s	-	0.7	μsec
Fall time.	t_f	-	0.7	μsec

PERFORMANCE TESTS

This transistor type is tested in strict accordance with Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

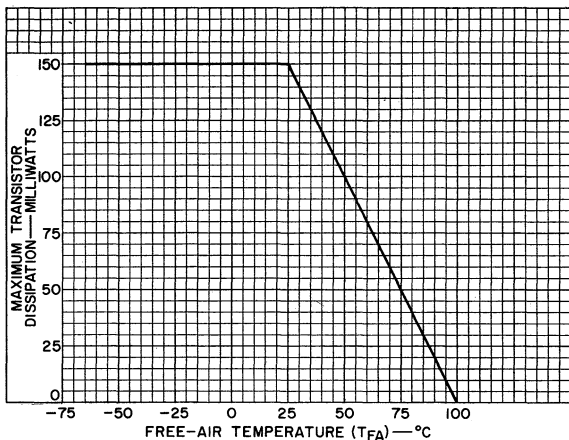
It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board, and to prevent the base from shorting to ground.

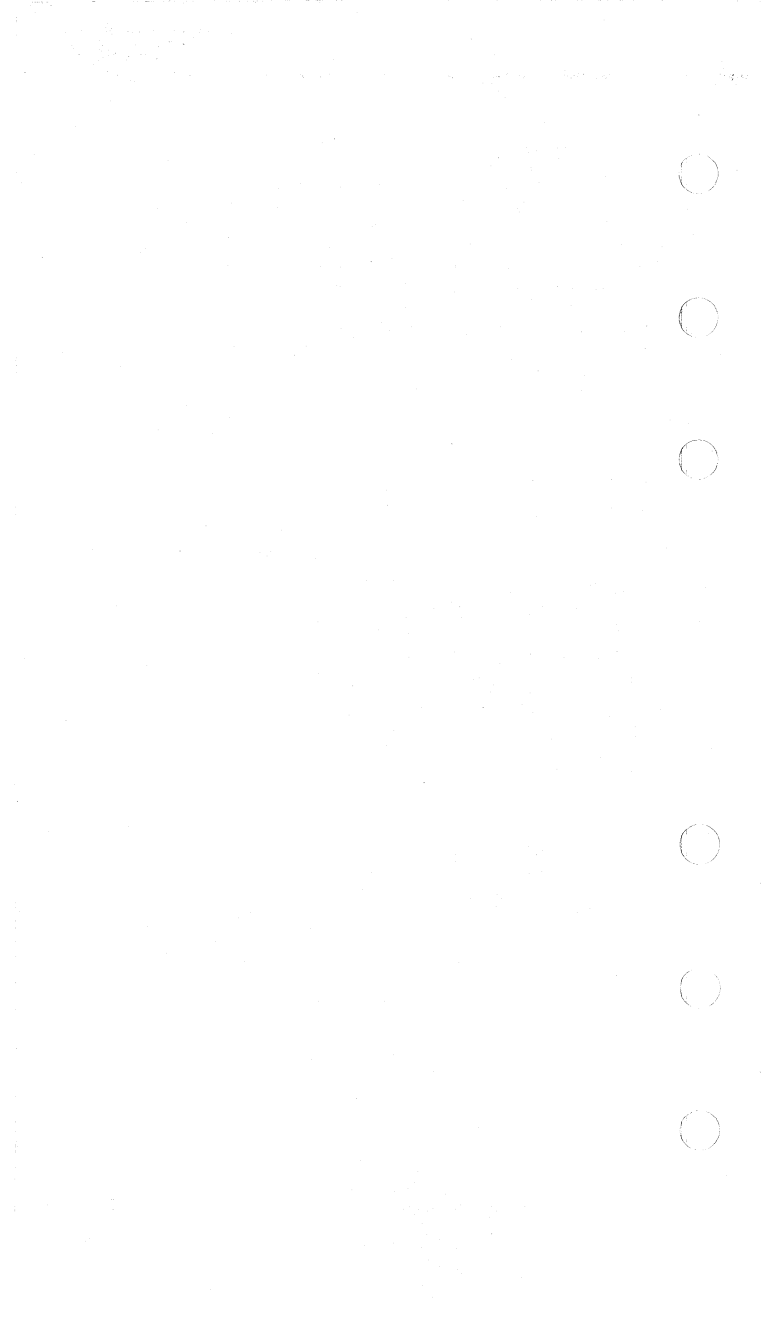
It is to be noted that the case of this transistor operates at the base voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

RATING CHART



92CS-11366





Transistor

GERMANIUM N-P-N ALLOY-JUNCTION TYPE
For Switching Applications in Commercial
and Military Data-Processing Equipment

The 2N388A is the same as the 2N388 except for the following items:

SWITCHING SERVICE

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CBO}	40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With dc base-to-emitter reverse bias volts = 0.5.	V_{CEV}	40 max.	volts

ELECTRICAL CHARACTERISTICS

		Min.	Max.	
DC Collector Current for dc collector-to-emitter volts = 40, dc base-to-emitter reverse bias volts = 0.5.				
	I_{CEV}	—	50	μa
DC Collector-Cutoff Current for emitter ma. = 0, dc collector volts =				
40.		—	40	μa
25.		—	10	μa
1		—	5	μa





Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

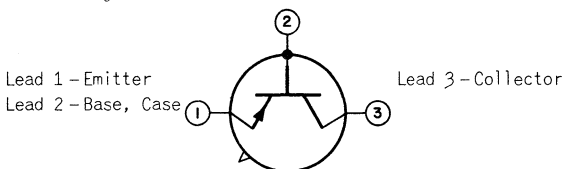
For Switching Applications in Industrial
and Military Data-Processing Systems

GENERAL DATA

Mechanical:

Dimensions See Outline TO-5 in General Section

Terminal Diagram: BOTTOM VIEW



SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CBO} -30 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With external resistance
between base and emitter
(ohms) = 10000 V_{CER} -15 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EBO} -20 max. volts

COLLECTOR CURRENT. I_C -200 max. ma

TRANSISTOR DISSIPATION:^a

At free-air temperature of
25° C or below P 150 max. mw

TEMPERATURE RANGE:

Storage. T_{stg} -65 to +100 °C

Operating (Junction) T_J -65 to +85 °C

LEAD TEMPERATURE:

For 10 seconds maximum^b. T_L 230 max. °C

^a See accompanying Rating Chart.

^b Measured 1/16" ± 1/32" down from seating plane.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless
otherwise specified. Free-air temperature of 25° C.

Min. Max.

DC Collector Breakdown Voltage

for dc collector ma. = -0.1,

dc emitter ma. = 0 BV_{CBO} -30 - volts



		Min.	Max.	
DC Emitter Breakdown Voltage for dc collector ma. = 0, dc emitter ma. = -0.1. . .	BV_{EBO}	-20	-	volts
DC Collector-to-Emitter Reach-Through Voltage ^c . .	V_{RT}	-15	-	volts
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = -50, dc base ma. = -5.	$V_{CE(sat)}$	-	-0.2	volt
DC Collector-Cutoff Current for dc collector volts = -15, dc emitter ma. = 0. .	I_{CBO}	-	-6	μa
DC Emitter-Cutoff Current for dc emitter volts = -10, dc collector ma. = 0 .	I_{EBO}	-	-6	μa
Collector-to-Base Capacitance for dc collector volts = -5, dc emitter ma. = 1.	C_{ob}	-	20	pf
DC Forward-Current Transfer Ratio: With dc collector-to- emitter volts = -1, dc collector ma. = -10. . .	h_{FE}	20	150	
With dc collector-to- emitter volts = -0.35, dc collector ma. = -200 .		10	-	
Small-Signal Short-Circuit Forward-Current Transfer- Ratio Cutoff Frequency for dc collector volts = -5, dc emitter ma. = 1	f_{hfb}	3	-	Mc

^c The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of -1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.

PERFORMANCE TESTS

This transistor type is tested in strict accordance with Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

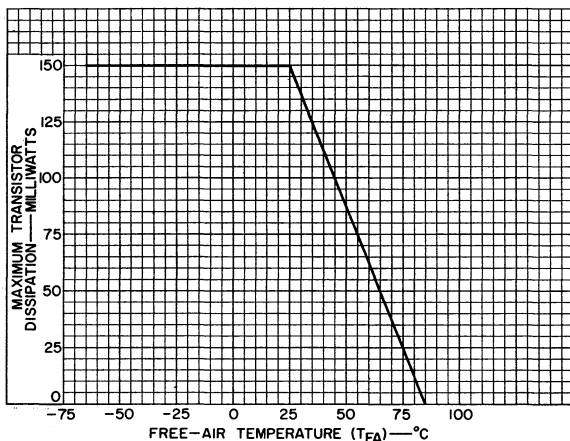
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat

of the soldering operation may crack the seals of the leads and damage the transistor.

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board, and to prevent the base from shorting to ground.

It is to be noted that the case of this transistor operates at the base voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

RATING CHART



92CS-11462



RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division Somerville, N. J.

DATA 2
4-62



Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

For Switching Applications in Industrial
and Military Data-Processing Systems

The 2N396 is the same as the 2N395 except for the following items:

SWITCHING SERVICE

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-EMITTER VOLTAGE:

With external resistance between
base and emitter (ohms) = 10000. V_{CER} -20 volts

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless
otherwise specified. Free-air temperature of 25° C.

		Min.	Max.	
DC Collector-to-Emitter Reach- Through Voltage ^c	V_{RT}	-20	-	volts
DC Collector-to-Emitter Satu- ration Voltage for dc col- lector ma. = -50, dc base ma. = -3.3	$V_{CE(sat)}$	-	-0.2	volt
DC Collector-Cutoff Current for dc collector volts = -20, dc emitter ma. = 0	I_{CBO}	-	-6	μa
DC Forward-Current Transfer Ratio:	h_{FE}			
With dc collector-to-emitter volts = -1, dc collector ma. = -10		30	150	
With dc collector-to-emitter volts = -0.35, dc collector ma. = -200		15	-	
Small-Signal Short-Circuit Forward-Current Transfer-Ratio Cutoff Frequency for dc col- lector volts = -5, dc emitter ma. = 1	f_{hfb}	5	-	Mc

^c The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of -1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.





Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

For Switching Applications in Industrial
and Military Data-Processing Systems

The 2N397 is the same as the 2N395 except for the following items:

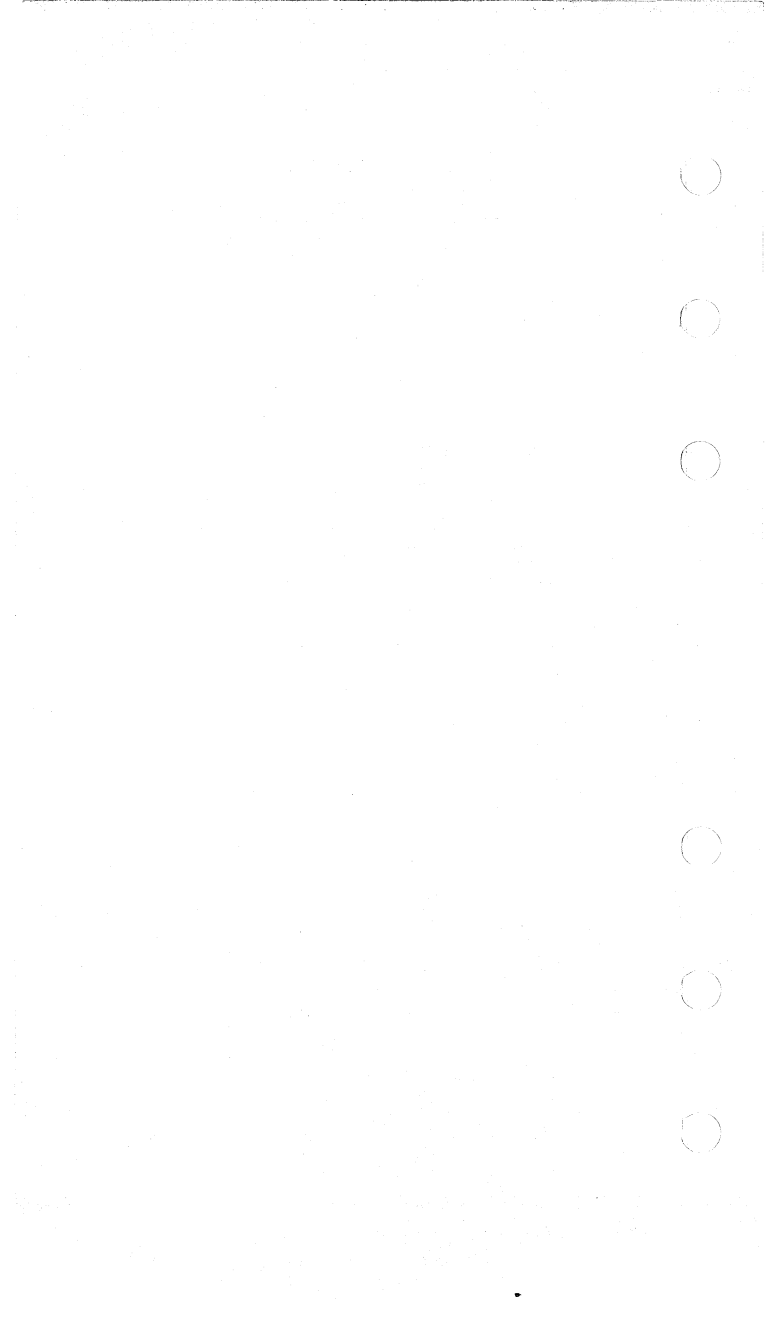
ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless
otherwise specified. Free-air temperature of 25° C.

Min. Max.

DC Collector-to-Emitter Saturation Voltage for dc collector ma. = -50, dc base ma. = -2.5. .	$V_{CE(sat)}$	-	-0.2	volt
DC Forward-Current Transfer Ratio:	h_{FE}			
With dc collector-to-emitter volts = -1, dc collector ma. = -10		40	150	
With dc collector-to-emitter volts = -0.35, dc collector ma. = -200.		20	-	
Small-Signal Short-Circuit Forward-Current Transfer-Ratio Cutoff Frequency for dc col- lector volts = -5, dc emitter ma. = 1	f_{hfb}	10	-	Mc





Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

For "On-Off" Control Applications
in Industrial and Military Equipment

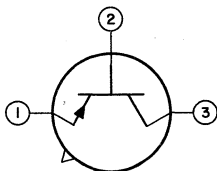
The 2N398B is a Direct Replacement for Type 2N398

GENERAL DATA

Mechanical:

Dimensions. See Outline TO-5 in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1—Emitter
Lead 2—Base



Lead 3—Collector

SWITCHING SERVICE

For direct "on-off" control of high-voltage, low-power devices such as neon indicators, relays, incandescent-lamp indicators, and indicating counters of electronic computers

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} -105 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With base short-circuited
to emitter. V_{CES} -105 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EBO} -50 max. volts

COLLECTOR CURRENT I_C -100 max. ma

EMITTER CURRENT I_E 100 max. ma

TRANSISTOR DISSIPATION:

At free-air temperatures:

From -65° to 25° C. 50 max. mw

At 55° C. 10 max. mw

TEMPERATURE RANGE:

Operating T_{OPR} -65 to 55 °C

Storage T_{STG} -65 to 85 °C

LEAD TEMPERATURE:^a

For 10 seconds maximum. T_L 230 max. °C

^a Measured 1/16" ± 1/32" along lead down from seating plane.

← Indicates a change.



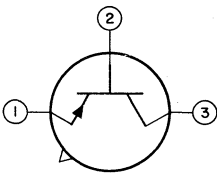
Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE
For "On-Off" Control Applications
in Industrial and Military Equipment

The 2N398B is a Direct Replacement for Type 2N398A

GENERAL DATA

Mechanical:

Dimensions. See Outline T0-5 in General Section
Terminal Diagram: 

Lead 1 - Emitter
Lead 2 - Base

Lead 3 - Collector

SWITCHING SERVICE

For direct "on-off" control of high-voltage, low-power devices such as neon indicators, relays, incandescent-lamp indicators, and indicating counters of electronic computers

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} -105 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With base short-circuited
to emitter. V_{CES} -105 max. volts 

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EBO} -50 max. volts

COLLECTOR CURRENT I_C -200 max. ma

EMITTER CURRENT I_E 200 max. ma

TRANSISTOR DISSIPATION:

At free-air temperatures:
From -65° to 25° C. 150 max. mw

Above 25° C Derate linearly 2 mw/°C

TEMPERATURE RANGE:

Operating T_{OPR} -65 to 100 °C

Storage T_{STG} -65 to 100 °C

LEAD TEMPERATURE:^a

For 3 seconds maximum T_L 250 max. °C

^a Measured 1/16" ± 1/32" along lead down from seating plane.

 Indicates a change.



OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.



Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

For "On-Off" Control Applications in
Industrial and Military Equipment

The 2N398B is Unilaterally Interchange-
able with Types 2N398 and 2N398A

GENERAL DATA

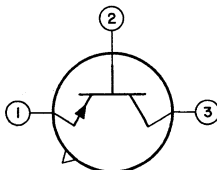
Mechanical:

Dimensions. See *Outline TO-5* in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector



SWITCHING SERVICE

For direct "on-off" control of high-voltage, low-power
devices such as neon indicators, relays, incandescent-lamp
indicators, and indicating counters of electronic computers

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} -105 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With base short-circuited
to emitter. V_{CES} -105 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EBO} -75 max. volts

COLLECTOR CURRENT I_C -200 max. ma

EMITTER CURRENT I_E 200 max. ma

TRANSISTOR DISSIPATION:

At free-air temperatures:

From -65° to 25° C. 250 max. mw

Above 25° C. Derate linearly 3.33 mw/°C

TEMPERATURE RANGE:

Operating T_{OPR} -65 to 100 °C

Storage T_{STG} -65 to 100 °C

LEAD TEMPERATURE:^a

For 10 seconds maximum. T_L 250 max. °C

^a Measured 1/16" ± 1/32" along lead down from seating plane.



ELECTRICAL CHARACTERISTICS

Unless otherwise specified, free-air temperature = 25° C

		Min.	Max.	
DC Collector-to-Emitter Reach-Through Voltage ^b	V_{RT}	-105	-	volts
DC Collector-to-Base Breakdown Voltage for dc collector ma. = -0.025, emitter current = 0	BV_{CBO}	-105	-	volts
DC Emitter-to-Base Breakdown Voltage for dc emitter ma. = -0.05, collector current = 0	BV_{EBO}	-75	-	volts
DC Base-to-Emitter Saturation Voltage for dc collector ma. = -5, dc base ma. = -0.25	$V_{BE(sat)}$	-	-0.3	volt
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = -5, dc base ma. = -0.25	$V_{CE(sat)}$	-	-0.25	volt
DC Collector-Cutoff Current: I_{CBO}				
With dc collector-to-base volts = -2.5, emitter current = 0		-	-6	μa
With dc collector-to-base volts = -105, emitter current = 0, free-air temperature = 25° C		-	-25	μa
71° C		-	-300	μa
DC Collector Current for dc collector-to-emitter voltage = -105, base short-circuited to emitter	I_{CES}	-	-300	μa
DC Collector Current for dc collector-to-emitter volts = -55, base-to-emitter resistance (ohms) = 10000	I_{CER}	-	-300	μa
DC Emitter-Cutoff Current I_{EBO} for collector current = 0, dc emitter-to-base volts = -2.5		-	-6	μa
-75		-	-50	μa
DC Forward-Current Transfer Ratio for dc collector-to-emitter volts = -0.25, dc collector ma. = -5	h_{FE}	20	-	
Small-Signal Short-Circuit Forward-Current Transfer Ratio for dc collector-to-emitter volts = -6, dc collector ma. = -1, frequency (kc) = 1	h_{fe}	40	-	

^b The dc collector-to-emitter reach-through voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base, and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of -1 volt.



	Min.	Max.	
Small-Signal Short-Circuit Forward- Current Transfer Ratio Cutoff Frequency for dc collector-to- base volts = -6, dc emitter ma. = 1	f_{hfb}	1	Mc
Thermal Resistance: Junction-to-free air.	θ_{JFA}	-	0.3 °C/mw

PERFORMANCE TESTS AND SPECIAL RATINGS

This transistor type is tested in strict accordance with rigid procedures conforming to the environmental, life, and mechanical requirements of Military Specification MIL-S-19500B.

Moisture Resistance:

This test is performed on a sample lot of transistors from each production run. The transistors are subjected to temperature cycling during this moisture-resistance test to provide alternate periods of condensation and drying. Increased effectiveness is also obtained by the use of a high temperature which intensifies the effects of humidity. At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CB0} , BV_{EB0} , and h_{FE} as shown under *Characteristics Endpoint Values*.

Salt Atmosphere:

This test is performed on a sample lot of transistors from each production run. The transistors are placed in a test chamber through which a salt atmosphere fog (at a temperature of 35° C) is passed for 24 + 2 - 0 hours. The fog concentration and velocity are adjusted so that the rate of salt deposition in the test area is 10000 to 50000 mg/meter²/day. At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CB0} , BV_{EB0} , and h_{FE} as shown under *Characteristics Endpoint Values*.

Temperature Cycling:

Cycles of Intermittent Operation. 10 min. cycles

This test is performed on a sample lot of transistors from each production run. The transistors undergo 10 temperature cycles from $-65 \pm 3^\circ \text{C}$ to $+100 \pm 3^\circ \text{C}$. At the end of the test, the transistors in the sample lot are required to meet the established limits for I_{CB0} and h_{FE} as shown under *Characteristics Endpoint Values*.

Thermal Shock:

Temperature Extremes. +100 to 0 °C

This test is performed on a sample lot of transistors from each production run. The transistors are completely immersed in water at a high temperature ($100 \pm 3^\circ \text{C}$) for not less than 15 seconds and then are immediately plunged into water at a low temperature ($0 \pm 3^\circ \text{C}$). At the end of the test, the transistors in the sample lot are required to meet the limits for I_{CB0} and h_{FE} as shown under *Characteristics Endpoint Values*.



Operating Life Performance:

This test is performed on a sample lot of transistors from each production run. The transistors are operated at a transistor dissipation of 150 mw (with $V_{CC} = -100$ v) in the accompanying *Operating-Life Test Circuit*, and at a free-air temperature of $25 \pm 3^{\circ}$ C. At the end of 1000 hours, the transistors in the sample lot are required to meet the limits for I_{CB0} , h_{FE} , BV_{CB0} , and BV_{EB0} as shown under *Characteristics Endpoint Values*.

Storage Life Performance (High Temperature):

This test is performed on a sample lot of transistors from each production run. The transistors are placed in a chamber at a temperature of $100 \pm 3^{\circ}$ C for a period of 1000 hours. At the end of 1000 hours, the transistors in the sample lot are required to meet the limits for I_{CB0} , h_{FE} , BV_{CB0} , and BV_{EB0} as shown under *Characteristics Endpoint Values*.

Constant Acceleration:

Centrifugal Acceleration. 10000 max. g

This test is performed on a sample lot of transistors from each production run. The transistors are rigidly mounted with suitable protection for the leads. A centrifugal acceleration of 10000 g is applied to the transistors for one minute in each of the orientations X_1 , Y_1 , and Z_1 . The acceleration is increased to 10000 g in not less than 20 seconds and then decreased gradually to zero in not less than 20 seconds. At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CB0} , BV_{EB0} , and h_{FE} as shown under *Characteristics Endpoint Values*.

Lead Fatigue:

Two leads of each transistor in the sample lot are subjected to a pull of 16 ± 1 ounces for three 90° arcs of the case (movement of the case, without torsion, to a position perpendicular to the pull axis and return to normal). All arcs on a single lead are in the same direction and in the same plane. The lead under test is restricted so that the bend starts $3/32 \pm 1/32$ inch from the case. Breakage of one or more of the leads under these test conditions constitutes failure.

Shock:

Impact Acceleration 1500 max. g

This test is performed on a sample lot of transistors from each production run. The transistors are rigidly mounted with suitable protection for the leads. An impact of 1500 g maximum is applied to the transistors by means of an impact testing machine. During this test, the transistors are subjected to five blows each with an acceleration of 1500 g and a duration of approximately 0.5 msec, in each of the orientations X_1 , Y_1 , Y_2 , and Z_1 . At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CB0} , BV_{EB0} , and h_{FE} as shown under *Characteristics Endpoint Values*.

Solderability:

This test is performed on a sample lot of transistors from each production run. The transistor leads are immersed in a flux composed of 25% (by weight) water-white resin and 75% isopropyl alcohol (90%) for a minimum of 5 seconds and then are dipped into molten solder (60% tin, and 40% lead, at $230 \pm 5^\circ \text{C}$) for $5 \pm 1/2$ seconds. At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CB0} , BV_{EB0} , and h_{FE} as shown under *Characteristics Endpoint Values*.

Variable-Frequency Vibration Performance:

100 to 2000 cps at a Constant Peak Acceleration of 20 g

This test is performed on a sample lot of transistors from each production run. The transistors are rigidly mounted on a vibration platform and subjected to vibration in each of the orientations X_1 , Y_1 , and Z_1 over a frequency range of 100 to 2000 cycles per second with approximately logarithmic variation of frequency and a constant peak acceleration of 20 g. The entire frequency range from 100 to 2000 cycles per second is covered in not less than four minutes. At the end of the test, the transistors in the sample lot are required to meet the limits for BV_{CB0} , BV_{EB0} , and h_{FE} as shown under *Characteristics Endpoint Values*.

Vibration Fatigue:

Vibrational Acceleration 20 max. g

This test is performed on a sample lot of transistors from each production run. The transistors are supplied with the required test voltages while rigidly mounted on a vibration platform. The transistors are then subjected to a simple harmonic motion at any single frequency between 40 and 100 cycles per second with a constant peak acceleration of 20 g. The vibration is applied for 32 hours minimum in each of the orientations X_1 , Y_1 , and Z_1 (for a total time of 96 hours minimum). At the end of the test, the transistors are required to meet the limits for I_{CB0} and h_{FE} as shown under *Characteristics Endpoint Values*.

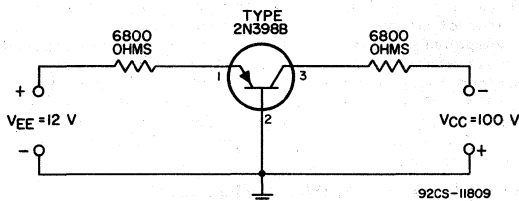
CHARACTERISTICS ENDPOINT VALUES

Characteristic	Test Conditions	LIMITS		
		Min.	Max.	Units
I_{CB0}	$V_{CB} = -2.5$ volts $I_E = 0$	-	-10	μa
h_{FE}	$V_{CE} = -0.25$ volt $I_C = -5$ ma	15.5	-	
BV_{CB0}	$I_C = -25$ μa $I_E = 0$	-90	-	volts
BV_{EB0}	$I_E = -50$ μa $I_C = 0$	-60	-	volts



2N398B

OPERATING-LIFE TEST CIRCUIT



OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE
For Computer Switching Applications

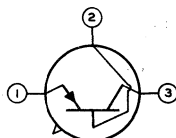
GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-5
Case.	Welded, Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	-25 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With dc emitter-to-base volts = -1.	-24 max.	volts
EMITTER-TO-BASE VOLTAGE	-12 max.	volts
COLLECTOR CURRENT	-100 max.	ma
EMITTER CURRENT	100 max.	ma
TRANSISTOR DISSIPATION: ^a		
At ambient temperature of 25° C or below.	150 max.	mw
At ambient temperature of 55° C	75 max.	mw
At ambient temperature of 71° C	35 max.	mw
AMBIENT TEMPERATURE RANGE:		
Operating	-65 to +85	°C
Storage	-65 to +100	°C
LEAD TEMPERATURE:		
For 10 seconds maximum.	255 max.	°C

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

→ Indicates a change.



2N404

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at ambient temperature of 25° C unless otherwise specified

Min. Typical Max.

DC Collector Break-down Voltage for dc collector ma. = -0.02, dc emitter ma. = 0	BV_{CBO}	-25	-40	-	volts
DC Punch-Through Voltage for dc emitter volts = -1	V_P	-24	-40	-	volts
DC Emitter Breakdown Voltage for dc emitter ma. = -0.02, dc collector ma. = 0	BV_{EBO}	-12	-35	-	volts
DC Collector-to-Emitter Saturation Voltage: $V_{CE(sat)}$ With dc collector ma. = -12, dc base ma. = -0.4		-	-0.1	-0.15	volt
With dc collector ma. = -24, dc base ma. = -1		-	-0.12	-0.2	volt
DC Base-to-Emitter Saturation Voltage: $V_{BE(sat)}$ With dc collector ma. = -12, dc base ma. = -0.4		-	-0.25	-0.35	volt
With dc collector ma. = -24, dc base ma. = -1		-	-0.32	-0.4	volt
DC Collector-Cutoff Current for dc collector volts = -12, dc emitter ma. = 0, ambient temperature = 25° C	I_{CBO}	-	-2	-5	μa
80° C		-	-45	-90	μa
DC Emitter-Cutoff Current for dc emitter volts = -2.5, dc collector ma. = 0	I_{EBO}	-	-1	-	μa
Collector-to-Base Capacitance for dc collector volts = -6, dc collector ma. = 0	C_{ob}	-	12	20	μf

→ Indicates a change.



DC Current Transfer Ratio:	h_{FE}				
With dc collector-to-emitter volts = -0.2, dc collector ma. = -24. . . .		24	40	-	
With dc collector-to-emitter volts = -0.15, dc collector ma. = -12. . . .		30	50	-	
Alpha-Cutoff Frequency for dc collector volts = -6, dc collector ma. = -1. . . .	f_{ab}	4	13	-	Mc
Stored Base Charge for dc collector ma. = -10, dc base ma. = -1	Q_S	-	800	1400	$\mu\text{coulombs}$
Thermal Time Constant.	τ_I	-	10	-	msec
Thermal Resistance:					
Junction-to-free air	R_T	-	-	500	$^{\circ}\text{C/watt}$

PERFORMANCE TESTS

This transistor type is tested in accordance with Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

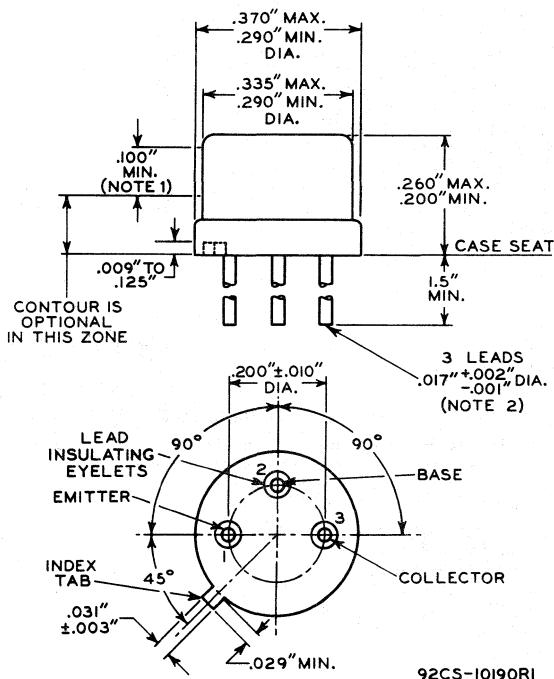
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

← Indicates a change.



2N404

JEDEC No. T0-5

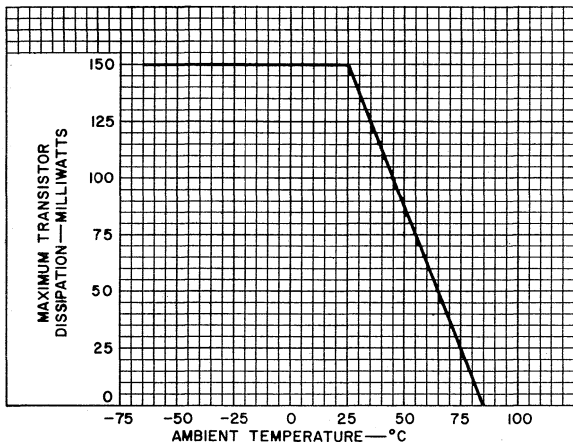


NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



RATING CHART



92CS-10907RI

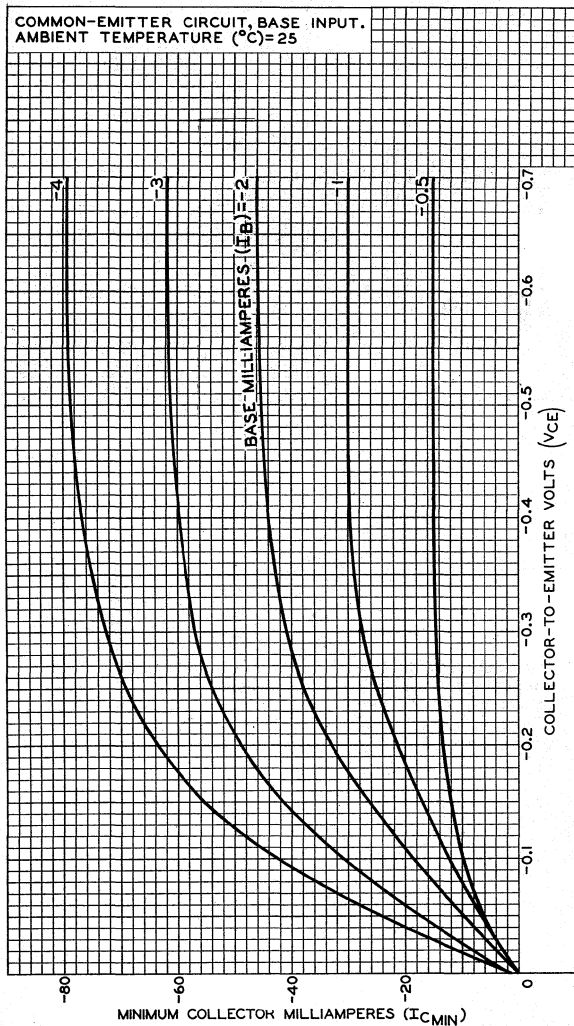
The following curves give the maximum and/or minimum characteristics values for this transistor. These curves were obtained from transistors at the extremes of the characteristics range in a 25-unit sample taken from a large number of production runs.



2N404

MINIMUM COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE ($^{\circ}\text{C}$) = 25



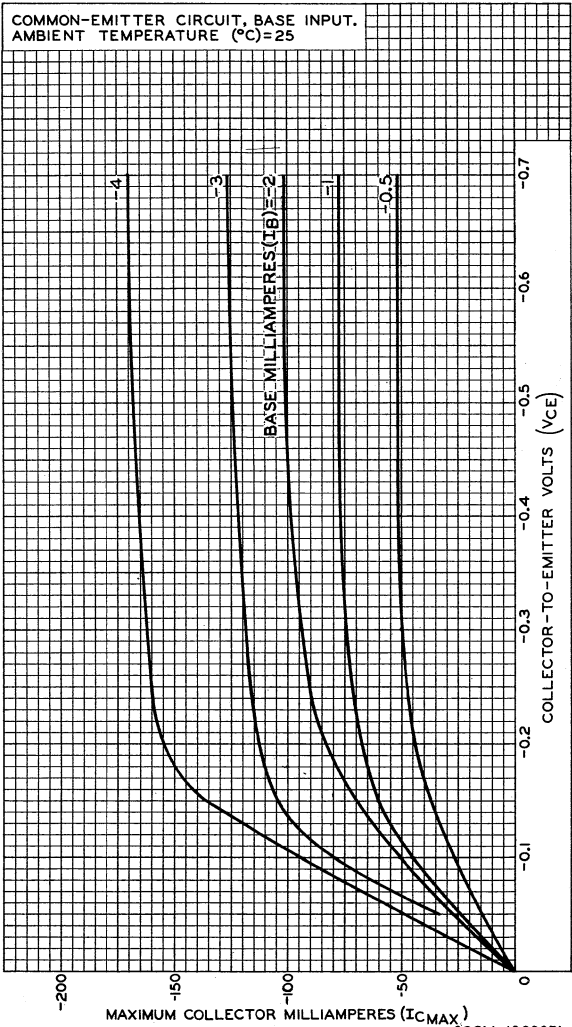
92CM-10898RI

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Semiconductor & Materials Division
Somerville, N. J.



MAXIMUM COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE ($^{\circ}\text{C}$) = 25



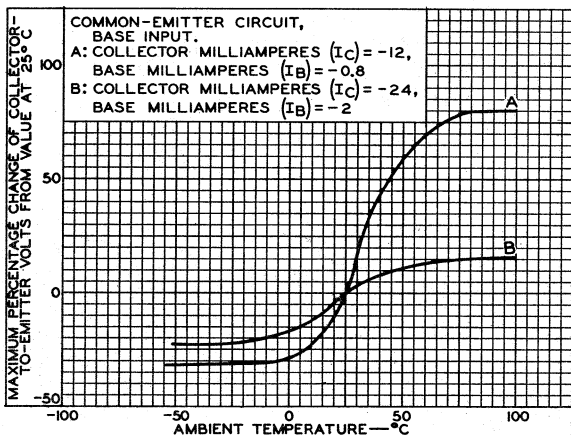
92CM-10899RI



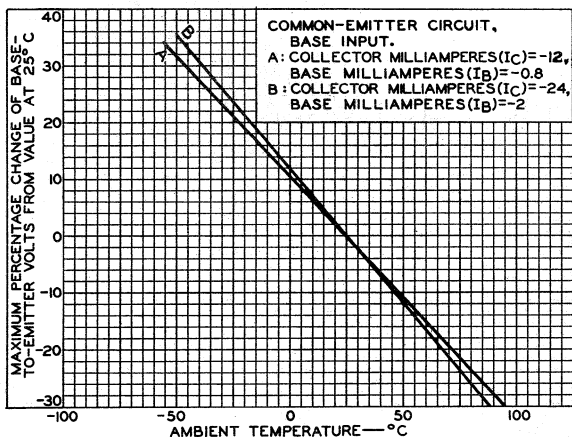
RADIO CORPORATION OF AMERICA
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Somerville, N. J.

DATA 4
6-61

MAXIMUM CHARACTERISTICS

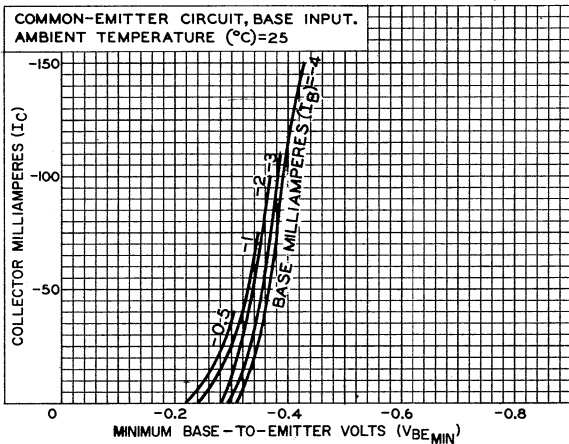


92CS-10895RI

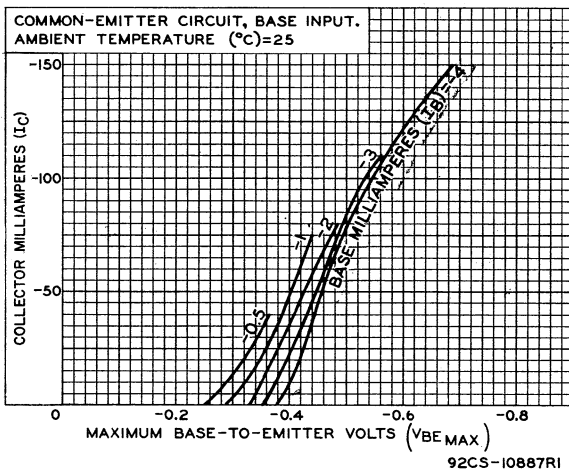


92CS-10889RI

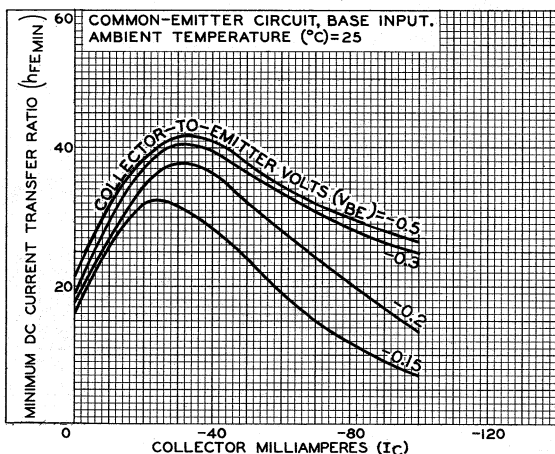
MINIMUM CHARACTERISTICS



MAXIMUM CHARACTERISTICS

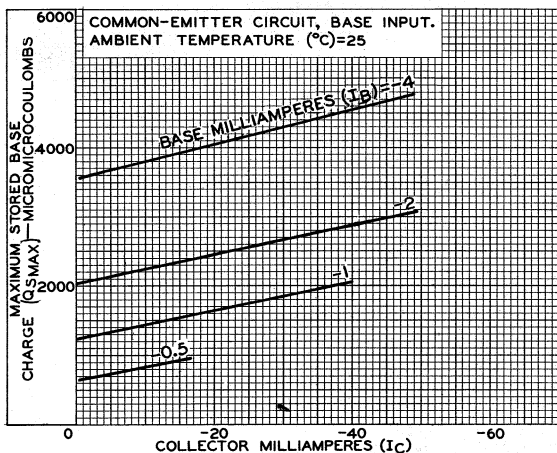


MINIMUM DC-CURRENT-TRANSFER-RATIO CHARACTERISTICS



92CS-10891RI

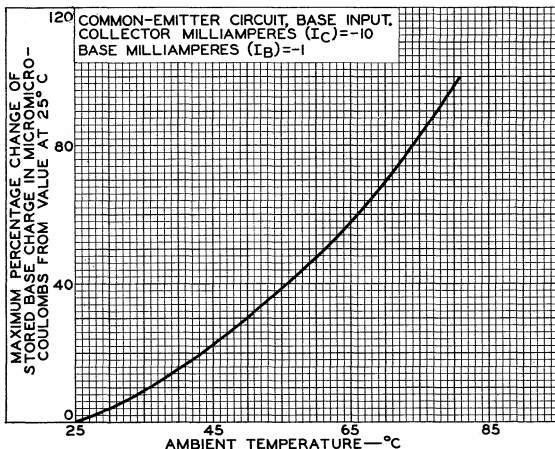
MAXIMUM STORED-BASE-CHARGE CHARACTERISTICS



92CS-10892RI

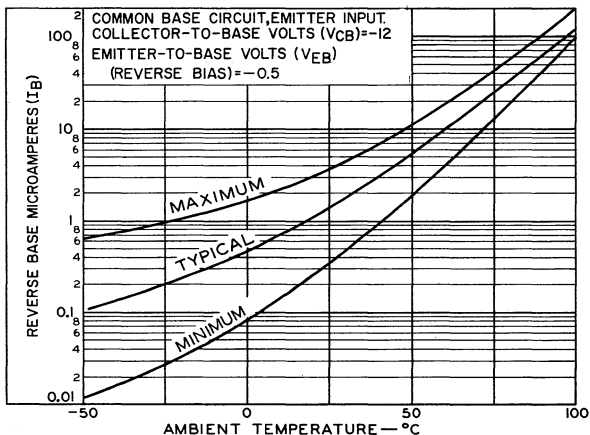


MAXIMUM CHARACTERISTIC



92CS-10893RI

REVERSE-BASE-CURRENT CHARACTERISTICS

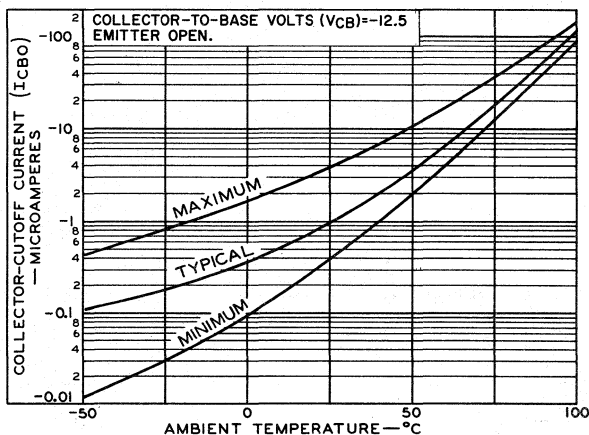


92CS-10884RI



2N404

COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



92CS-10885RI



Transistor

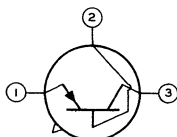
GERMANIUM P-N-P ALLOY-JUNCTION TYPE
For Computer Switching Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-5
Case.	Welded, Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1—Emitter
Lead 2—Base



Lead 3—Collector

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	-40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With dc emitter-to-base volts = -1.	-35 max.	volts
EMITTER-TO-BASE VOLTAGE	-25 max.	volts
COLLECTOR CURRENT	-150 max.	ma
EMITTER CURRENT	150 max.	ma
TRANSISTOR DISSIPATION: ^a		
At ambient temperature of 25° C	150 max.	mw
At ambient temperature of 55° C	90 max.	mw
At ambient temperature of 71° C	60 max.	mw
AMBIENT-TEMPERATURE RANGE:		
Operating and storage	-65 to +100	°C
LEAD TEMPERATURE:		
For immersion in molten solder		
for 10 seconds maximum.	255 max.	°C

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.



2N404A

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and ambient temperature of 25° C unless otherwise specified

Min. Typical Max.

DC Collector Breakdown				
Voltage for dc collector ma. = -0.02, dc emitter current = 0.	BV_{CBO}	-40	-	- volts
DC Emitter Breakdown				
Voltage for dc emitter ma. = -0.02, dc collector current = 0.	BV_{EBO}	-25	-	- volts
DC Punch-Through Voltage for dc emitter volts = -1.	V_{PT}	-35	-	- volts
DC Base-to-Emitter Saturation Voltage:	$V_{BE(sat)}$			
For dc collector ma. = -12, dc base ma. = -0.4.		-	-	-0.35 volt
For dc collector ma. = -24, dc base ma. = -1.		-	-	-0.4 volt
DC Collector-to-Emitter Saturation Voltage:	$V_{CE(sat)}$			
For dc collector ma. = -12, dc base ma. = -0.4.		-	-	-0.15 volt
For dc collector ma. = -24, dc base ma. = -1.		-	-	-0.2 volt
Stored Base Charge (See accompanying Test Circuit)	Q_S	-	-	1400 $\mu\text{coulombs}$
DC Collector-Cutoff Current for dc collector volts = -12, dc emitter current = 0, ambient temperature of:	I_{CBO}			
25° C		-	-	-5 μa
80° C		-	-	-90 μa
Alpha-Cutoff Frequency for dc collector volts = -6, dc collector ma. = -1.	f_{ab}	4	-	- Mc
DC Current Transfer Ratio:	h_{FE}			
For dc collector-to-emitter volts = -0.15, dc collector ma. = -12.		30	-	-
For dc collector-to-emitter volts = -0.2, dc collector ma. = -24.		24	-	-



Collector-to-Base Capac-
itance for dc collector
volts = -6, dc emitter
current = -1, frequency

(Mc) = 2. C_{op} - - - 20 $\mu\mu f$
Thermal Time Constant . . . τ_1 - 10 - msec

Thermal Resistance:

Collector junction to
free ambient air. . . . R_T - - 500 $^{\circ}C/watt$

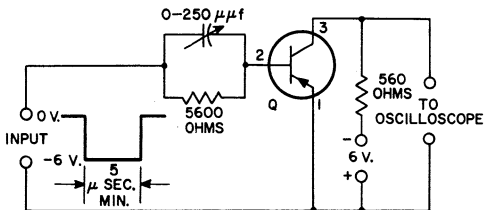
OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.

This transistor is intended for use in single-side printed circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.

STORED-BASE-CHARGE TEST CIRCUIT



92CS-11042RI

Q: Transistor type 2N404A

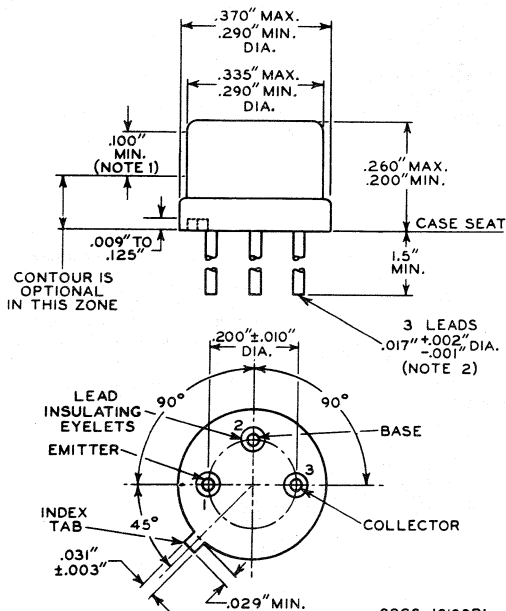


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Somerville, N. J.

DATA 2
6-61

2N404A

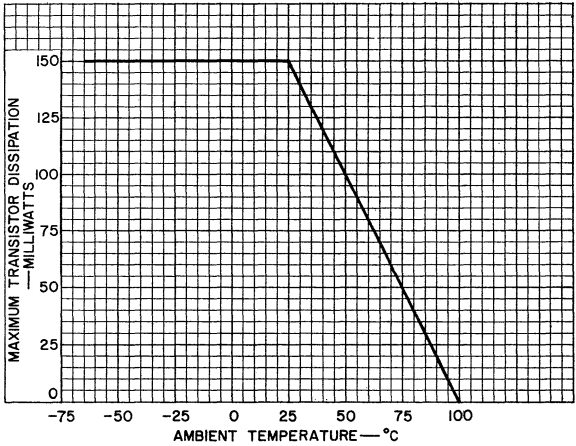
JEDEC No. T0-5



NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

RATING CHART



92CS-11044RI



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DATA 3
6-61



2N405

2N405 JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For audio-frequency driver-amplifier applications

The 2N405 is the same as the 2N406 except for the following items:

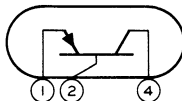
Mechanical:

Maximum Overall Length.	0.697"
Maximum Seated Length	0.495"
Maximum Diameter.	0.260"
Base.	Small-Round Linotetrar 3-Pin (JETEC No.E3-25)

Pin 1 - Emitter

Pin 4 - Collector

Pin 2 - Base



OPERATING CONSIDERATIONS

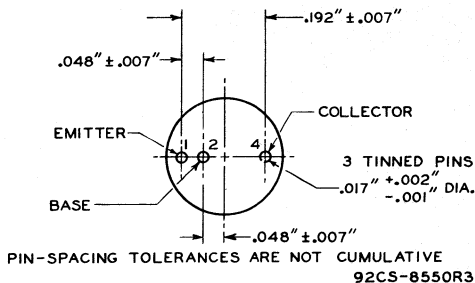
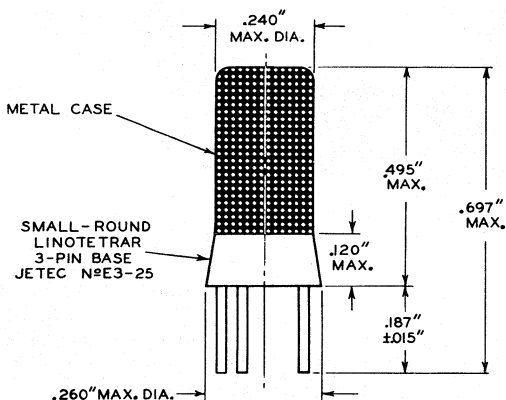
The 2N405 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

2N405



2N405

JUNCTION TRANSISTOR





2N406

2N406

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

*For audio-frequency driver-amplifier applications***GENERAL DATA****Electrical, At Ambient Temperature of 25° C:**

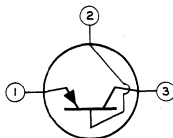
Maximum DC Collector Current for dc collector-to-base voltage of -12 volts with emitter open.	-14	μa
Maximum DC Emitter Current for dc emitter-to-base voltage of -2.5 volts with collector open	-14	μa

Mechanical:

Operating Position	Any
Maximum Length (Excluding flexible leads)	0.405"
Maximum Diameter	0.240"
Dimensional Outline	JETEC No.T0-1
Case	Metal
Envelope Seals	Hermetic
Leads, Flexible	3
Minimum length	1.5"
Orientation and diameter	See Dimensional Outline

BOTTOM VIEW

Lead 1 - Emitter

Lead 3 - Collector
(Adjacent
to red dot
on side of
case)

Lead 2 - Base

AUDIO-FREQUENCY DRIVER-AMPLIFIER — Class A**Maximum Ratings, Absolute Values:**

COLLECTOR-TO-BASE VOLTAGE (DC + Peak AC)	-20 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE (DC + Peak AC)	-18 max.	volts
EMITTER-TO-BASE VOLTAGE (DC + Peak AC)	-2.5 max.	volts
DC COLLECTOR CURRENT	-35 max.	ma
DC EMITTER CURRENT	35 max.	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C	150 max.	mW
At ambient temperature of 55° C	50 max.	mW
At ambient temperature of 71° C	20 max.	mW
AMBIENT TEMPERATURE (During operation)	71 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C

Characteristics, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage	-6	volts
DC Emitter Current	1	ma



2N406

JUNCTION TRANSISTOR

Power Gain:

With load resistance = 8500 ohms,
and input resistance = 750 ohms 43 db

Small-Signal T Parameters:*

DC Collector-to-Emitter Voltage (V_{CE})	-6	volts
DC Emitter Current (I_E)	1	ma
Emitter Resistance (r_e)	17	ohms
Base Resistance (r_b)	500	ohms
Mutual Resistance (r_m)	2.04	megohms
Collector Resistance (r_c)	2.1	megohms
Current Transfer Ratio (α_f) [■]	~35	

Small-Signal Hybrid- π Parameters:*

DC Collector-to-Emitter Voltage (V_{CE})	-6	volts
DC Emitter Current (I_E)	1	ma
Resistance r_{bb}	120	ohms
Conductance $g_{b'e}$	1070	μ hos
Conductance g_{ce}	6.5	μ hos
Conductance $g_{b'c}$	0.295	μ ho
Capacitance $C_{b'e}$	9430	μ uf
Capacitance $C_{b'c}$	40	μ uf
Intrinsic Transconductance (g_m)	37500	μ hos

Small-Signal H Parameters:*

DC Collector-to-Emitter Voltage (V_{CE})	-6	volts
DC Emitter Current (I_E)	1	ma
Input Resistance, ac output circuit shorted (h_i)	1115	ohms
Reverse Voltage Transfer Ratio, input circuit open (h_r)	2.93×10^{-4}	
Forward Current Transfer Ratio, ac output circuit shorted (h_f)	35	
Output Conductance, input circuit open (h_o)	17.2	μ hos

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-6	volts
DC Emitter Current	1	ma
Frequency at which the current transfer ratio drops to 0.707 times its value at 1 kc	650	Mc

* As derived from corresponding equivalent circuit shown under type 2N104.

■ Measured at 1 kc.

OPERATING CONSIDERATIONS

The 2N406 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N406 are usually soldered to the circuit elements. Soldering of the leads may be made



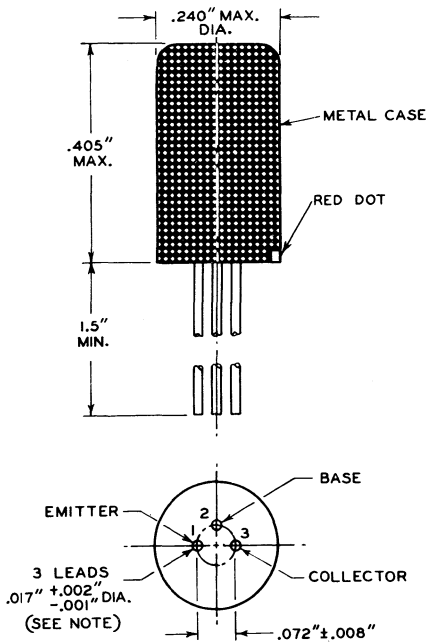
2N406

2N406

JUNCTION TRANSISTOR

close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N406, the temperature of the solder should not exceed 230°C for a maximum immersion period of 10 seconds.



92CS-9148R2

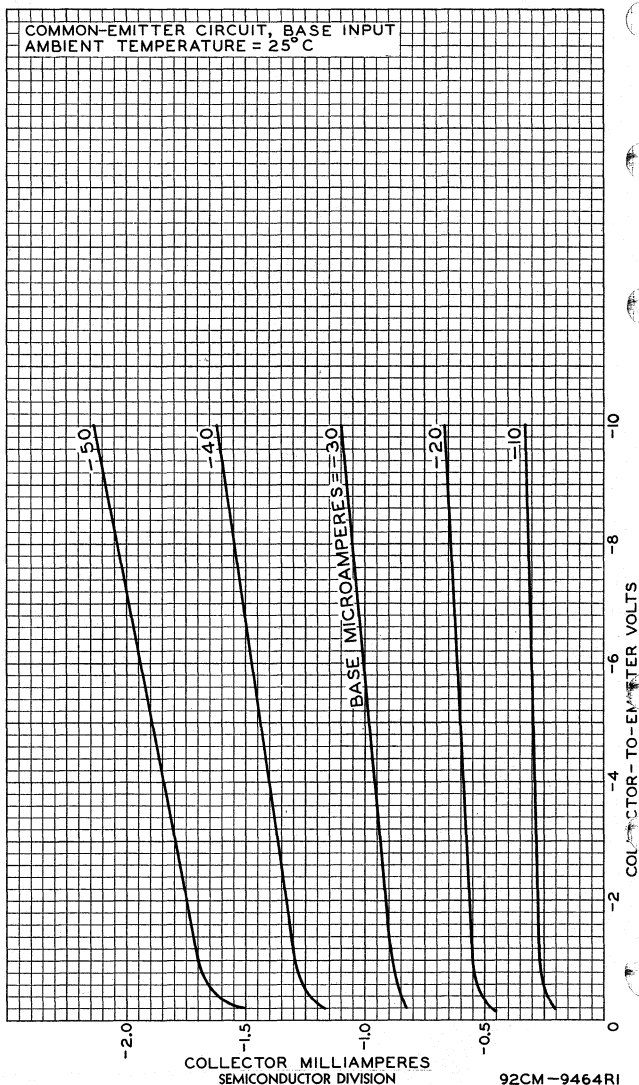
NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.050''$ AND $0.250''$ FROM THE BASE SEAT. BETWEEN $0.250''$ AND $1.50''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

2N406



2N406

AVERAGE COLLECTOR CHARACTERISTICS





2N407

2N407

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For large-signal audio-frequency applications

The 2N407 is the same as the 2N408 except for the following items:

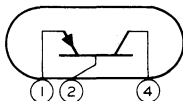
Mechanical:

Maximum Overall Length	0.697"
Maximum Seated Length	0.495"
Maximum Diameter	0.260"
Base	Small-Round Linotetrar 3-Pin (JETEC No.E3-25)

Pin 1 - Emitter

Pin 4 - Collector

Pin 2 - Base



OPERATING CONSIDERATIONS

The 2N407 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

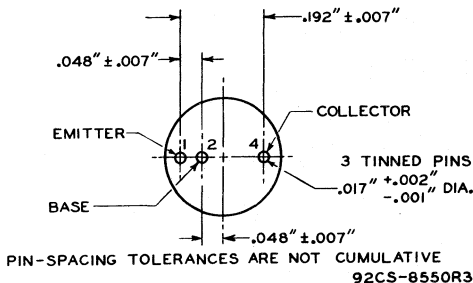
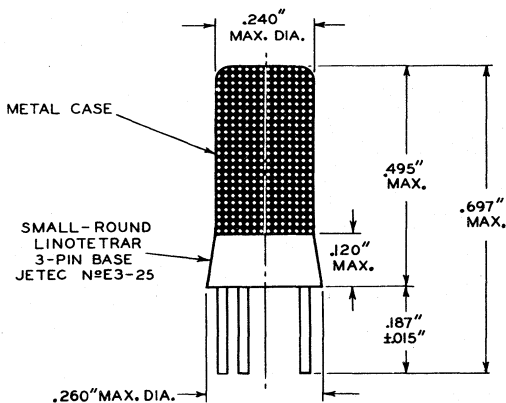
In class B service, when the 2N407 is operated at ambient temperatures other than 25° C, the base-to-emitter voltage should be reduced or increased by approximately 0.002 volt for each degree the ambient temperature is above or below 25° C, respectively. When this transistor is operated under varying ambient temperatures, some form of temperature compensation may be used in the base-to-emitter circuit to hold the operating point constant.

2N407



2N407

JUNCTION TRANSISTOR





2N408

2N408

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For large-signal audio-frequency applications

GENERAL DATA

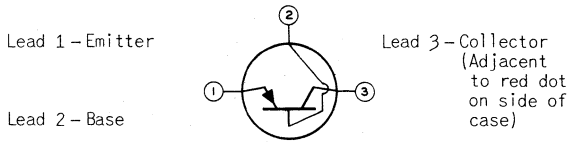
Electrical, At Ambient Temperature of 25° C:

Maximum DC Collector Current for dc collector-to-base voltage of -12 volts with emitter open.	-14	μ a
Maximum DC Emitter Current for dc emitter-to-base voltage of -2.5 volts with collector open.	-14	μ a

Mechanical:

Operating Position	Any
Maximum Length (Excluding flexible leads).	0.405"
Maximum Diameter	0.204"
Dimensional Outline.	JETEC No. TO-1
Case	Metal
Envelope Seals	Hermetic
Leads, Flexible.	3
Minimum length	1.5"
Orientation and diameter	See Dimensional Outline

BOTTOM VIEW



AUDIO-FREQUENCY AMPLIFIER — Class B

Maximum Ratings, Absolute Values:

COLLECTOR-TO-BASE VOLTAGE.	-20 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE	-18 max.	volts
EMITTER-TO-BASE VOLTAGE.	-2.5 max.	volts
COLLECTOR CURRENT.	-70 max.	ma
EMITTER CURRENT.	70 max.	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C	150 max.	mW
At ambient temperature of 55° C	50 max.	mW
At ambient temperature of 71° C	20 max.	mW
AMBIENT TEMPERATURE (During operation)	71 max.	°C
STORAGE-TEMPERATURE RANGE.	-65 to +85	°C

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage.	-1	volt
DC Collector Current	-50	ma
Large-Signal DC Current Transfer Ratio	65	



2N408

JUNCTION TRANSISTOR

Typical Push-Pull Operation, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

Unless otherwise specified, values are for 2 transistors

DC Collector-to-Emitter Supply Voltage.	-4.5	-9	volts
DC Base-to-Emitter Voltage . .	-0.15	-0.15	volt
Peak Collector Current (Per transistor).	-35	-40	ma
Zero-Signal DC Collector Current (Per transistor). . . .	-2	-2	ma
Max.-Signal DC Collector Current (Per transistor). . . .	-11.5	-13	ma
Signal-Source Impedance (Base to base)	1500	1500	ohms
Load Impedance (Collector to collector)	400	800	ohms
Signal Frequency	1	1	kc
Circuit Efficiency	60	69	%
Power Gain	30	33	db
Total Harmonic Distortion. . .	10 max.	10 max.	%
Max.-Signal Power Output . . .	75	160	mW

OPERATING CONSIDERATIONS

The 2N408 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

In class B service, when the 2N408 is operated at ambient temperatures other than 25° C, the base-to-emitter voltage should be reduced or increased by approximately 0.002 volt for each degree the ambient temperature is above or below 25° C, respectively. When this transistor is operated under varying ambient temperatures, some form of temperature compensation may be used in the base-to-emitter circuit to hold the operating point constant.

The flexible leads of the 2N408 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N408, the temperature of the solder should not exceed 230° C for a maximum immersion period of 10 seconds.

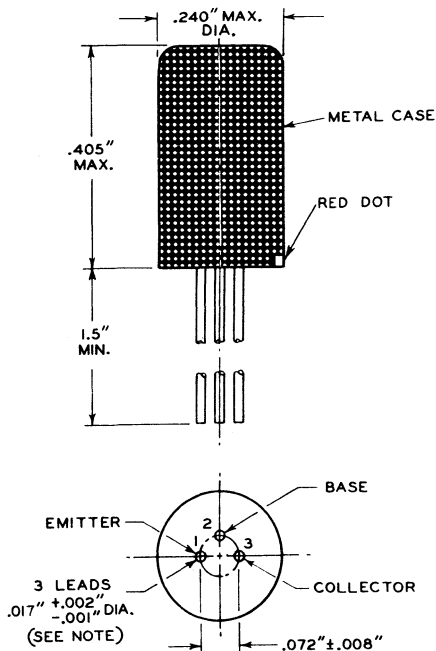
Curves shown under Type 2N109 also apply to the 2N408



2N408

JUNCTION TRANSISTOR

2N408



92CS-9148R2

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.





2N409

2N409

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For 455-kc intermediate-frequency applications

The 2N409 is the same as the 2N410 except for the following items:

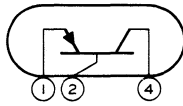
Mechanical:

Maximum Overall Length.	0.697"
Maximum Seated Length	0.495"
Maximum Diameter.	0.260"
Base.	Small-Round Linotetrar 3-Pin (JETEC No.E3-25)

Pin 1 - Emitter

Pin 4 - Collector

Pin 2 - Base



OPERATING CONSIDERATIONS

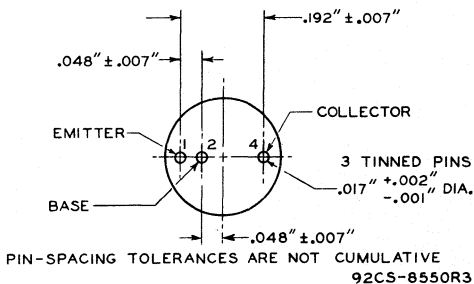
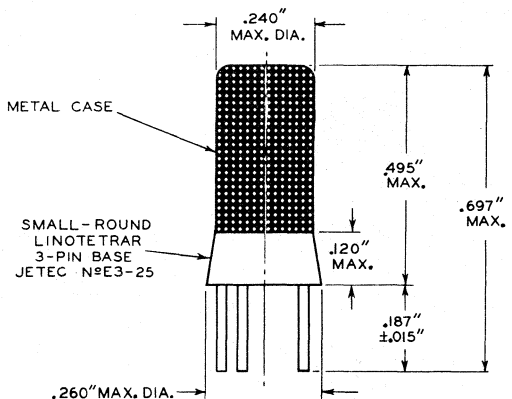
The 2N409 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

2N409



2N409

JUNCTION TRANSISTOR





2N410

2N410

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For 455-kc intermediate-frequency applications

GENERAL DATA

Electrical, At Ambient Temperature of 25° C:

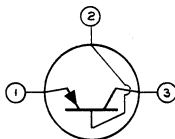
Minimum DC Collector-to-Base Voltage for dc collector current of -10 μ a with emitter open.	-13	volts
Maximum DC Collector Current for dc collector-to-base voltage of -13 volts with emitter open.	-10	μ a
Maximum DC Emitter Current for dc emitter-to-base voltage of -0.5 volt with collector open.	-12	μ a

Mechanical:

Operating Position	Any
Maximum Length (Excluding flexible leads).	0.405"
Maximum Diameter	0.240"
Dimensional Outline.	JETEC No. TO-1
Case	Metal
Envelope Seals	Hermetic
Leads, Flexible.	3
Minimum length	1.5"
Orientation and diameter	See Dimensional Outline

BOTTOM VIEW

Lead 1 - Emitter

Lead 3 - Collector
(Adjacent
to red dot
on side of
case)

Lead 2 - Base

INTERMEDIATE-FREQUENCY AMPLIFIER

Maximum Ratings, Absolute Values:

DC COLLECTOR-TO-BASE VOLTAGE	-13 max.	volts
DC EMITTER-TO-BASE VOLTAGE	-0.5 max.	volt
DC COLLECTOR CURRENT	-15 max.	ma
DC EMITTER CURRENT	15 max.	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C.	80 max.	mW
At ambient temperature of 55° C.	35 max.	mW
At ambient temperature of 71° C.	10 max.	mW
AMBIENT TEMPERATURE (During operation)	71 max.	°C
STORAGE-TEMPERATURE RANGE.	-65 to +85	°C



2N410

JUNCTION TRANSISTOR

Characteristics, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage	-9	-9	volts
DC Emitter Current	0.5	1	ma
Current Transfer Ratio [■]	-45	-48	

Small-Signal Hybrid- π Parameters:*

DC Collector-to-Emitter Voltage (V_{CE})	-9	-9	volts
DC Emitter Current (I_E)	0.5	1	ma
Resistance $r_{bb'}$	85	75	ohms
Conductance $g_{b'e}$	425	800	μ hos
Conductance g_{ce}	4.6	8.6	μ hos
Conductance $g_{b'c}$	0.22	0.25	μ ho
Capacitance $C_{b'e}$	540	1100	μ mf
Capacitance $C_{b'c}$	9.5	9.5	μ mf
Intrinsic Transconductance (g_m)	19300	38600	μ hos
Frequency [•] for unity power amplification	13	14	Mc

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-9	-9	volts
DC Emitter Current	0.5	1	ma
Current Transfer Ratio [■]	0.978	0.980	
Frequency at which the current transfer ratio drops to 0.707 times its value at 1 kc.	6.8	6.7	Mc

Typical Operation, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage	-9	-9	volts
DC Emitter Current	0.5	1	ma
Input Resistance	1000	500	ohms
Output Resistance	70000	30000	ohms
Spot Noise Factor [▲]	4.5	4.5	db
Maximum Power Gain [▲]	38.8	37.8	db
Useful Power Gain	28.4 [§]	30.4 [†]	db

* As derived from corresponding equivalent circuit shown under type 2N104.

• This frequency (figure of merit) may be calculated from the equation

$$f = \frac{1}{4\pi} \sqrt{\frac{g_m}{r_{bb'} C_{b'c} C_{b'e}}}$$

■ Measured at 1 kc.

▲ Measured in a single-tuned unilateralized circuit matched to the generator and load impedances for maximum transfer of power. Transformer insertion losses not included. (Unilateralization is a special case of neutralization in which the resistive as well as the reactive feedback parameters are balanced out. Unilateralization changes a bilateral network into a unilateral network).

§ A transformer insertion loss of 10.4 db is included in this figure.

† A transformer insertion loss of 6.6 db is included in the figure.



2N410

2N410

JUNCTION TRANSISTOR

OPERATING CONSIDERATIONS

The 2N410 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

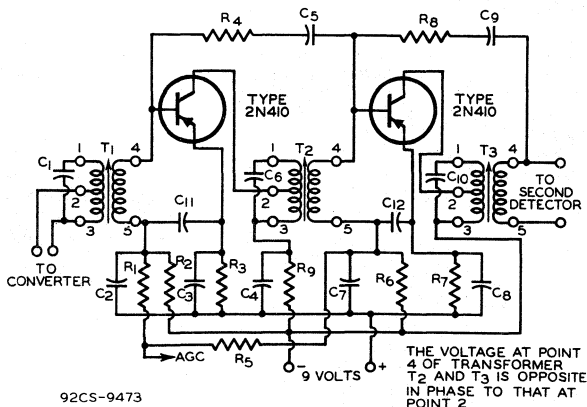
The *flexible leads* of the 2N410 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N410, the temperature of the solder should not exceed 230°C for a maximum immersion period of 10 seconds.



2N410

JUNCTION TRANSISTOR

TYPICAL 455-KC INTERMEDIATE-FREQUENCY
AMPLIFIER CIRCUIT

NOTE: THE DESIGN OF THIS CIRCUIT PROVIDES STABLE OPERATION AND INTERCHANGEABILITY OF RCA-2N410 TRANSISTORS.

C1 C6 C10: 220 $\mu\mu\text{f}$
 C2: 50 μf
 C3 C4 C8: 0.05 μf
 C5: 75 $\mu\mu\text{f}$
 C7: 25 μf
 C9: 33 $\mu\mu\text{f}$
 C11 C12: 0.1 μf
 R1: 12000 ohms

R2: 0.15 megohm
 R3 R7: 820 ohms
 R4: 560 ohms
 R5: 18000 ohms
 R6: 0.1 megohm
 R8: 2000 ohms
 R9: 560 ohms

Transformer:

Reflected resistance of primary
 between terminals 2 and 3

with secondary terminated

Reflected resistance of secondary
 with primary terminated

Turns ratios:

Terminals 1 and 3 to terminals

2 and 3

Terminals 1 and 3 to terminals

4 and 5

Terminals 2 and 3 to terminals

4 and 5

Core Material

Unloaded Q (mounted in chassis)

Loaded Q (mounted in chassis)

	T1	T2	T3	
Reflected resistance of primary between terminals 2 and 3 with secondary terminated	206000	29000	10900	ohms
Reflected resistance of secondary with primary terminated	1000	500	1000	ohms
Turns ratios:				
Terminals 1 and 3 to terminals 2 and 3	1.17	2.48	3.16	
Terminals 1 and 3 to terminals 4 and 5	16.8	18.9	10.43	
Terminals 2 and 3 to terminals 4 and 5	14.35	7.62	3.3	
Core Material	Ferrite	Ferrite	Ferrite	
Unloaded Q (mounted in chassis)	110	61	110	
Loaded Q (mounted in chassis)	35	35	35	

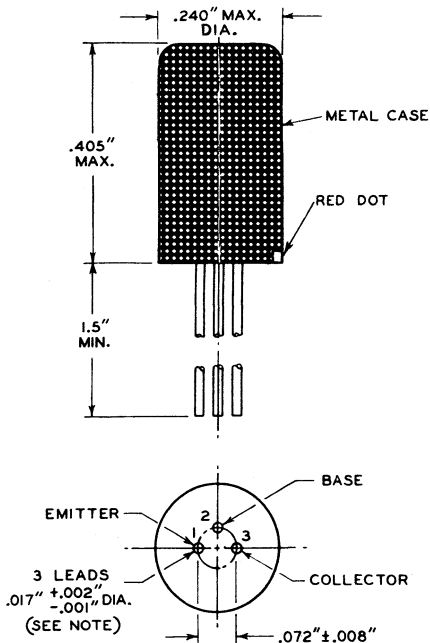
Devices and arrangements shown or described herein may use patents of RCA or others. Information contained herein is furnished without responsibility by RCA for its use and without prejudice to RCA's patent rights.



2N410

JUNCTION TRANSISTOR

2N410



92CS-9148R2

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

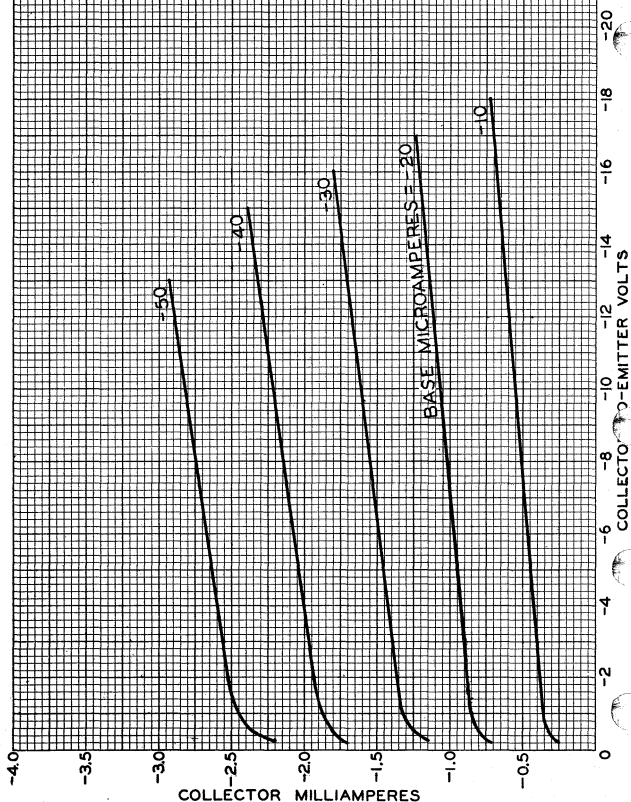
2N410



2N410

AVERAGE COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT
AMBIENT TEMPERATURE = 25° C



COLLECTOR MILLIAMPERES

SEMICONDUCTOR DIVISION

RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

92CM-8849RI



2N411

2N411

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For 540-to 1600-kc converter applications

The 2N411 is the same as the 2N412 except for the following items:

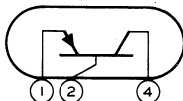
Mechanical:

Maximum Overall Length.	0.697"
Maximum Seated Length	0.495"
Maximum Diameter.	0.260"
Base.	Small-Round Linotetrar 3-Pin (JETEC No.E3-25)

Pin 1 - Emitter

Pin 4 - Collector

Pin 2 - Base



OPERATING CONSIDERATIONS

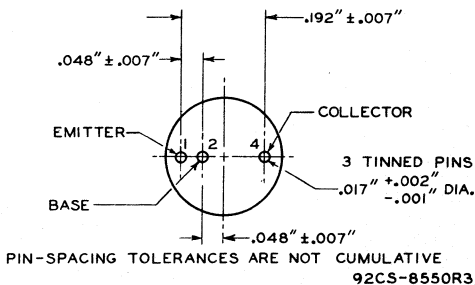
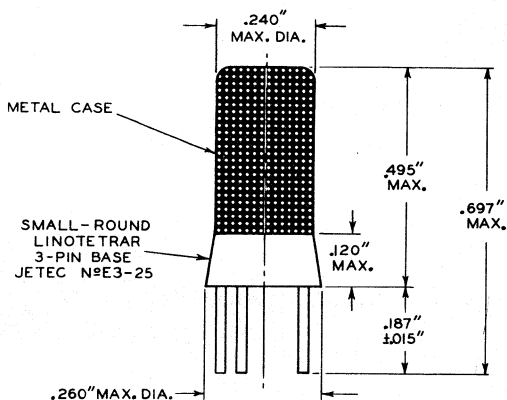
The 2N411 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

2N411



2N411

JUNCTION TRANSISTOR





2N412

2N412

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For 540-to 1600-kc converter applications

GENERAL DATA

Electrical, At Ambient Temperature of 25° C:

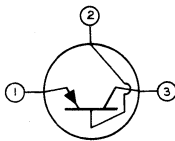
Minimum DC Collector-to-Base Voltage for dc collector current of -10 μ a with emitter open	-13	volts
Maximum DC Collector Current for dc collector-to-base voltage of -13 volts with emitter open	-10	μ a
Maximum DC Emitter Current for dc emitter-to-base voltage of -0.5 volt with collector open	-12	μ a

Mechanical:

Operating Position	Any
Maximum Length (Excluding flexible leads)	0.405"
Maximum Diameter	0.240"
Dimensional Outline	JETEC No. TO-1
Case	Metal
Envelope Seals	Hermetic
Leads, Flexible	3
Minimum length	1.5"
Orientation and diameter	See Dimensional Outline

BOTTOM VIEW

Lead 1 - Emitter

Lead 3 - Collector
(Adjacent
to red dot
on side of
case)

Lead 2 - Base

CONVERTER SERVICE

Maximum Ratings, Absolute Values:

DC COLLECTOR-TO-BASE VOLTAGE	-13 max.	volts
DC EMITTER-TO-BASE VOLTAGE	-0.5 max.	volt
DC COLLECTOR CURRENT	-15 max.	ma
DC EMITTER CURRENT	15 max.	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C	80 max.	mw
At ambient temperature of 55° C	35 max.	mw
At ambient temperature of 71° C	10 max.	mw
AMBIENT TEMPERATURE (During operation) . .	71 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C



2N412

JUNCTION TRANSISTOR

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage	-9	volts
DC Emitter Current	0.6	ma
Current Transfer Ratio [■]	75	

Small-Signal Hybrid- π Parameters:*

DC Collector-to-Emitter Voltage (V_{CE}) . . .	-9	volts
DC Emitter Current (I_E)	0.6	ma
Resistance $r_{bb'}$	85	ohms
Conductance $g_{b'e}$	480	μ mhos
Conductance $g_{c'e}$	5.4	μ mhos
Conductance $g_{b'c}$	0.23	μ mho
Capacitance $C_{b'e}$	650	μ uf
Capacitance $C_{b'c}$	9.5	μ uf
Intrinsic Transconductance (g_m)	22600	μ mhos
Frequency [●] for unity power amplification .	16.5	Mc

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-9	volts
DC Emitter Current	0.6	ma
Current Transfer Ratio [■]	0.987	
Frequency at which the current transfer ratio drops to 0.707 times its value at 1 kc.	10	Mc

Typical Operation, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage	-9	volts
DC Emitter Current	0.6	ma
Input Resistance	700	ohms
Output Resistance	75000	ohms
RMS Base-to-Emitter Oscillator Injection Voltage	100	* mv
Signal Frequency	1	Mc
Useful Conversion Power Gain	32	db

■ Measured at 1 kc.

* As derived from corresponding equivalent circuit shown under type 2N104.

● This frequency (figure of merit) may be calculated from the equation

$$f = \frac{1}{4\pi} \sqrt{\frac{g_m}{r_{bb'} C_{b'c} C_{b'e}}}$$

OPERATING CONSIDERATIONS

The 2N412 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The flexible leads of the 2N412 are usually soldered to the circuit elements. Soldering of the leads may be made



2N412

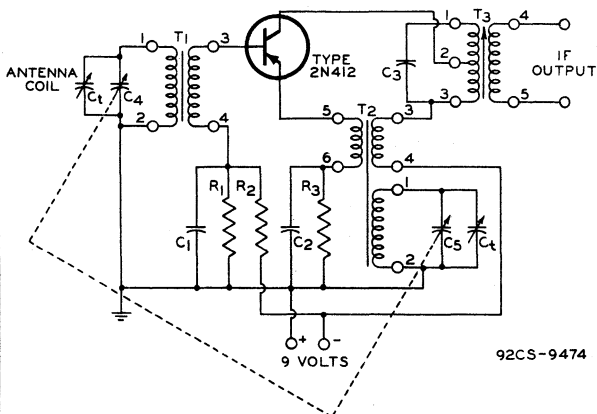
2N412

JUNCTION TRANSISTOR

close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N412, the temperature of the solder should not exceed 230°C for a maximum immersion period of 10 seconds.

TYPICAL SELF-EXCITED CONVERTER CIRCUIT

C1: $0.05\ \mu\text{f}$ C2: $0.04\ \mu\text{f}$ C3: $220\ \mu\text{f}$ C4: 12 to $230\ \mu\text{f}$ (variable)C5: 10 to $105\ \mu\text{f}$ (variable) C_t : 2 to $20\ \mu\text{f}$ (variable)

R1: 6800 ohms

R2: 18000 ohms

R3: 3900 ohms

T1: RF Transformer; low-loss ferrite core; unloaded Q (mounted in chassis), 212 at 1 Mc. Primary: 75 turns of 7/41 Litz wire space wound (spacing equal to diameter of wire) in single layer and centered on core; reflected resistance with secondary terminated, 0.3 megohm; inductance (approx.), 353 microhenries. Secondary: 4.5 turns of No.34 SSE wire wound on ground end of core.

T2: Oscillator Transformer; low-loss ferrite core; unloaded Q (mounted in chassis), 100 at 1455 kc. Primary: 133 turns of 7/41 Litz wire between terminals 1 and 2; inductance (approx.); 207 microhenries. Secondary: 10 turns of No.34 SSE wire between terminals 3 and 4; 4 turns of No.34 SSE wire between terminals 5 and 6.

T3: See next page.

2N412

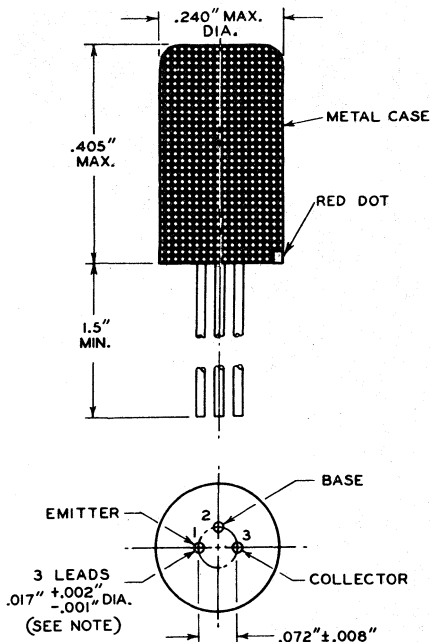


2N412

JUNCTION TRANSISTOR

T₃: 1F Transformer; ferrite core; unloaded Q (mounted in chassis), 110 at 455 kc; loaded Q (mounted in chassis), 35 at 455 kc. Turns ratios: terminals 1 and 3 to terminals 2 and 3, 1.17; terminals 2 and 3 to terminals 4 and 5, 14.35; terminals 1 and 3 to terminals 4 and 5, 16.8. Primary: reflected resistance with secondary terminated, 0.206 megohm. Secondary: reflected resistance with primary terminated, 1000 ohms.

Devices and arrangements shown or described herein may use patents of RCA or others. Information contained herein is furnished without responsibility by RCA for its use and without prejudice to RCA's patent rights.



92CS-9148R2

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

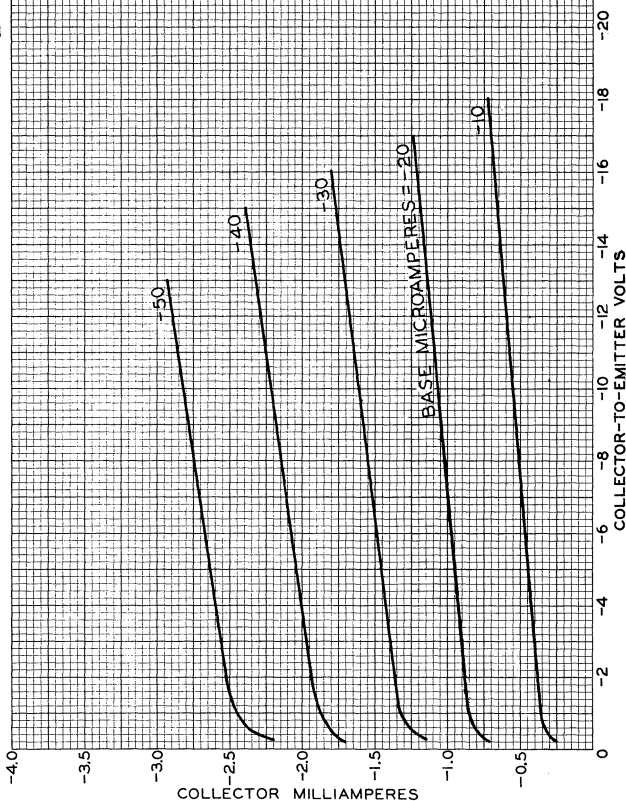


2N412

2N412

AVERAGE COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT
AMBIENT TEMPERATURE = 25° C



COLLECTOR MILLIAMPERES

SEMICONDUCTOR DIVISION

RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

92CM-8849RI



Junction Transistor

GERMANIUM P-N-P ALLOY TYPE

For Medium-Speed Switching Service in Commercial and Military Data-Processing Systems

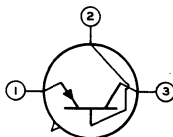
GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-5
Case.	Welded, Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	-30 max.	volts
EMITTER-TO-BASE VOLTAGE	-20 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
Base-to-emitter volts = 1	-20 max.	volts
Base open	-15 max.	volts
PEAK COLLECTOR CURRENT.	-400 max.	ma
DC COLLECTOR CURRENT.	-200 max.	ma
TRANSISTOR DISSIPATION: ^a		
At ambient temperature of 25° C	150 max.	mw
At ambient temperature of 55° C	75 max.	mw
AMBIENT-TEMPERATURE RANGE:		
Operating and storage	-65 to +85	°C
LEAD TEMPERATURE:		
For immersion in molten solder for 10 seconds maximum	240 max.	°C

^a See accompanying Rating Chart.



ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to the base unless otherwise specified. Ambient temperature of 25° C.

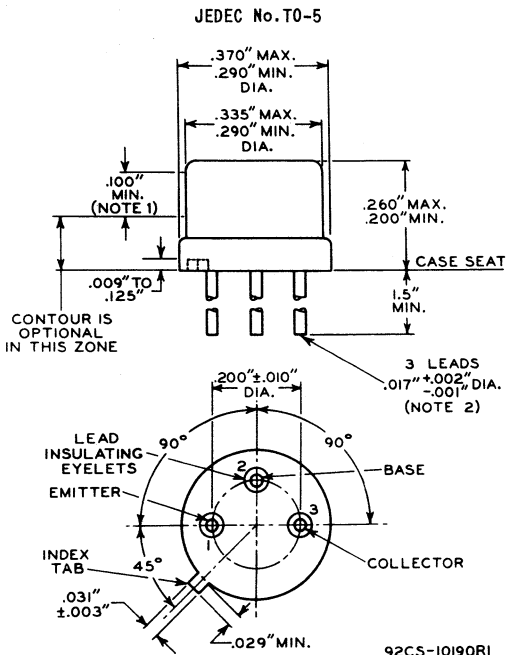
	Min.	Typical	Max.	
DC Collector-Cutoff Current for dc collector volts = -12, emitter open.	I_{CBO}	-	-2	-5 μa
DC Emitter-Cutoff Current for dc emitter volts = -12, collector open.	I_{EBO}	-	-2	-5 μa
Small-Signal Current Transfer Ratio for dc collector-to-emitter volts = -6, dc emitter ma. = 1, frequency of 1 kc.	h_{fe}	-	80	-
Small-Signal Open-Circuit Reverse-Voltage Transfer Ratio for dc collector volts = -6, dc emitter ma. = 1, frequency of 1 kc.	h_{rb}	-	0.5×10^{-3}	-
Alpha-Cutoff Frequency for dc collector volts = -6, dc emitter ma. = 1.	$f_{\alpha b}$	-	8	- Mc
Small-Signal Short-Circuit Input Impedance for dc collector volts = -6, dc emitter ma. = 1, frequen- cy of 1 kc.	h_{ib}	-	30	- ohms
Extrinsic Base Resistance for dc collector-to- emitter volts = -6, dc emitter ma. = 1, fre- quency of 6 Mc.	$r_{bb'}$	-	120	- ohms
Collector-to-Base Capacitance for dc collector volts = -6, dc emitter ma. = 1.	C_{ob}	-	11	- $\mu\mu f$
Power Gain for dc collector- to-emitter volts = -6, dc emitter ma. = 1, frequen- cy of 1.5 Mc.	PG	-	16	- db
Noise Factor for dc collec- tor-to-emitter voltage = -6, dc emitter ma. = 1, frequency of 1.5 Mc.	NF	-	6	- db

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.



The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.

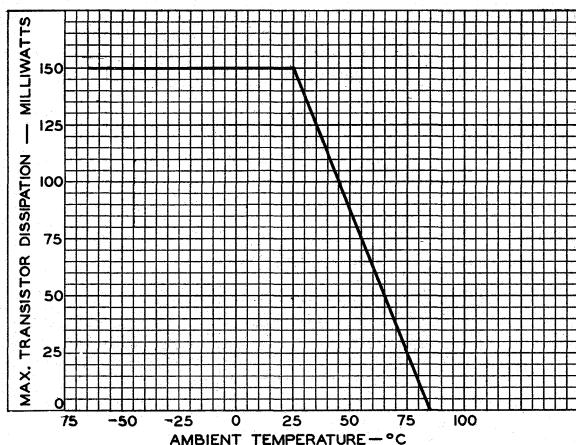


NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



RATING CHART



92CS-10232R1



Power Transistor

GERMANIUM P-N-P ALLOY TYPE

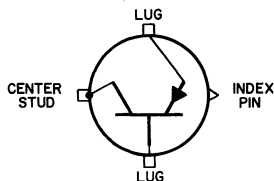
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position. Any
Maximum Seated Length 0.520"
Maximum Diameter. 1.250"
Dimensional Outline JEDEC No. T0-36
Case. Welded, Metal
Seals Hermetic
Terminal Diagram (See *Dimensional Outline*):

BOTTOM VIEW



INDUSTRIAL SERVICE

*Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and audio-
amplifier, relay- and solenoid-actuating circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter-to-base reverse biased

(DC emitter-to-base volts = -1.5) . . . -40 max. volts

EMITTER-TO-BASE VOLTAGE -20 max. volts

COLLECTOR CURRENT -15 max. amp

EMITTER CURRENT 15 max. amp

BASE CURRENT. -4 max. amp

TRANSISTOR DISSIPATION:^a

At case temperatures^b of 25° C or below. 150 max. watts

CASE-TEMPERATURE^b RANGE:

Operating and storage -65 to +100 °C

Typical Operation:

*In a common-emitter, base-input, power-
switching circuit at case temperature^b of 25° C*

DC Supply Voltage -12 volts

DC Base-Bias Voltage. 6 volts

"On" DC Collector Current -12 amp

"Turn-On" Base Current. -2 amp

"Turn-Off" Base Current 0 amp

← Indicates a change.



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DATA 1
8-61

2N441

Switching Time:

Rise time	15	μ sec
Fall time	15	μ sec

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

^b Measured at any point on seating surface.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25° C unless otherwise specified

Min. Typical Max.

DC Collector-to-Emitter

Breakdown Voltage:

With base connected

to emitter, dc

collector amperes

= -0.3 BV_{CES} -40 - - volts

With base open:

For dc collector

amperes = -0.3 BV_{CEO} - -40 - volts

For dc collector

amperes = -1^c -25 - - volts

DC Base-to-Emitter Voltage

for dc collector-to-

emitter volts = -2, dc

collector amperes = -5. V_{BE} - -0.65 - volt

DC Collector-to-Emitter

Saturation Voltage

for dc collector amperes

= -12, dc base amperes = -2. V_{CE} - -0.3 - volt

DC Emitter Voltage for dc (sat)

collector volts = -40,

dc emitter current = 0. V_{EB} - - -1 volt

DC Punch-Through Voltage.

. V_{PT} -40 - - volts

DC Emitter-Cutoff Current

for dc emitter volts =

-20, dc collector I_{EBO} - -1 -4 ma

current = 0

DC Collector-Cutoff Current:

With dc collector volts

= -2, dc emitter I_{CBO} - -100 - μ a

current = 0

With dc collector volts - -2 -4 ma

= -40, dc emitter

current = 0

With dc collector volts

= -40, dc emitter

current = 0, case

temperature^b = 71° C - - -15 ma

→ Indicates a change.



DC Current Transfer Ratio for dc collector-to- emitter volts = -2, dc collector amperes =	h_{FE}			
-5.		20	-	40
-12.		-	20	-
Beta-Cutoff Frequency for dc collector-to- emitter volts = -6, dc collector amperes = -5.	f_{ae}	-	10	- kc
Thermal Resistance: Junction-to-case.	R_T	-	0.35	0.5 °C/watt
Thermal Capacity for pulse duration of 1 to 10 milliseconds.		-	0.075	- watt- sec/°C
Thermal Time Constant . . .	τ_1	-	26.25	- msec

^b Measured at any point on seating surface.

^c Tested by sweep method to prevent excessive heating of collector junction.

PERFORMANCE TESTS

This transistor type is designed to pass the environmental tests specified in Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connection can be made to the base and emitter lugs by means of clips or by soldering directly to the lugs. When soldering connections are made to the lugs, care should be taken to conduct excessive heat away from the lug seals, otherwise the heat of the soldering operation will crack the glass seals of the lugs and damage the transistor.

This transistor is provided with a single-ended stud for mounting to a heat sink and for electrical connection to the collector. (See accompanying *Suggested Mounting Arrangement*). Electrical connection to the base and to the emitter is made to their respective lugs.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

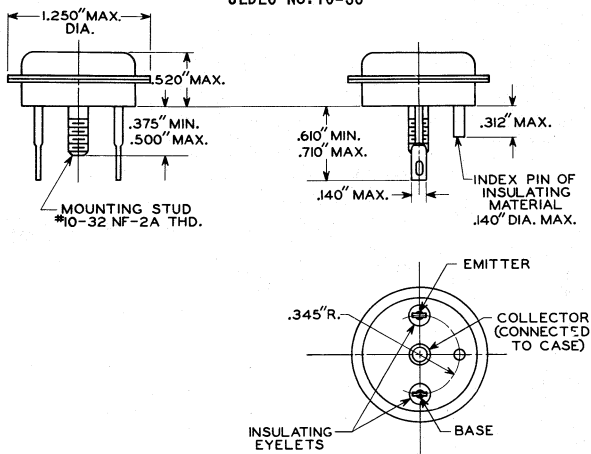
The maximum torque on mounting stud should not exceed 12 inch-pounds.

← Indicates a change.



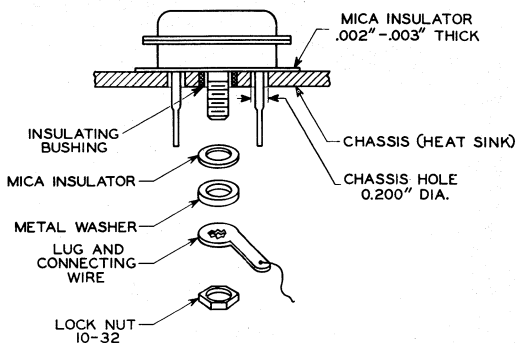
2N441

JEDEC No. T0-36



92CM-10612RI

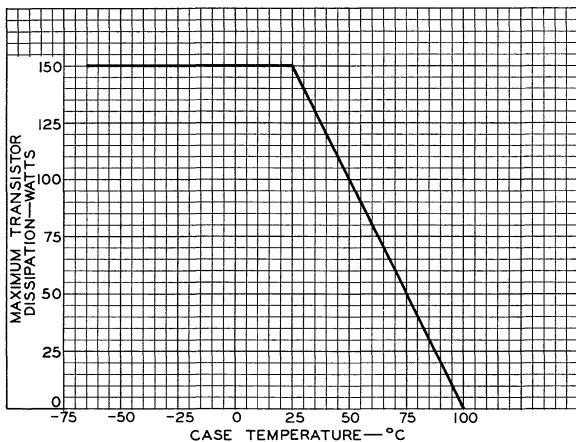
SUGGESTED MOUNTING ARRANGEMENT



92CS-10624RI

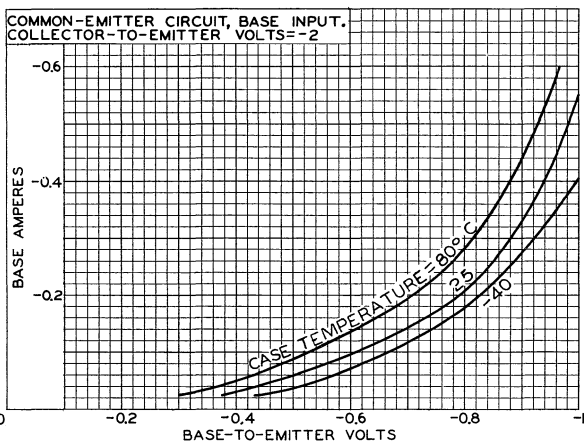


RATING CHART



92CS-10702RI

TYPICAL BASE CHARACTERISTICS



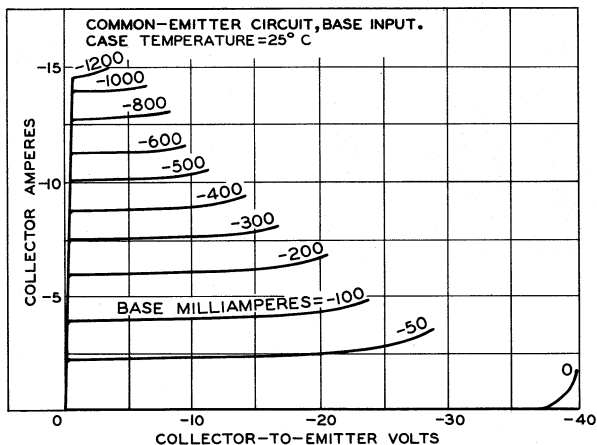
92CS-10717



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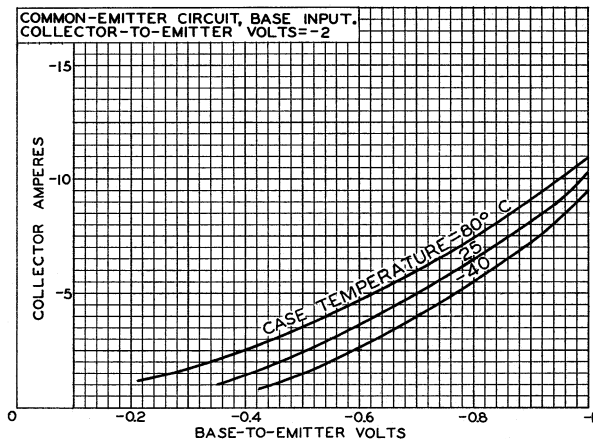
DATA 3
8-61

TYPICAL COLLECTOR CHARACTERISTICS



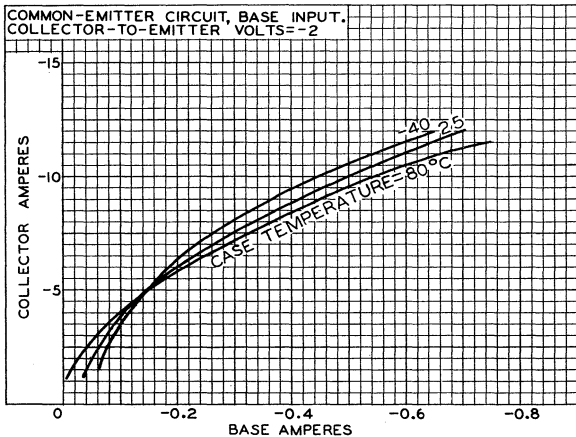
92CS-10732

TYPICAL CHARACTERISTICS



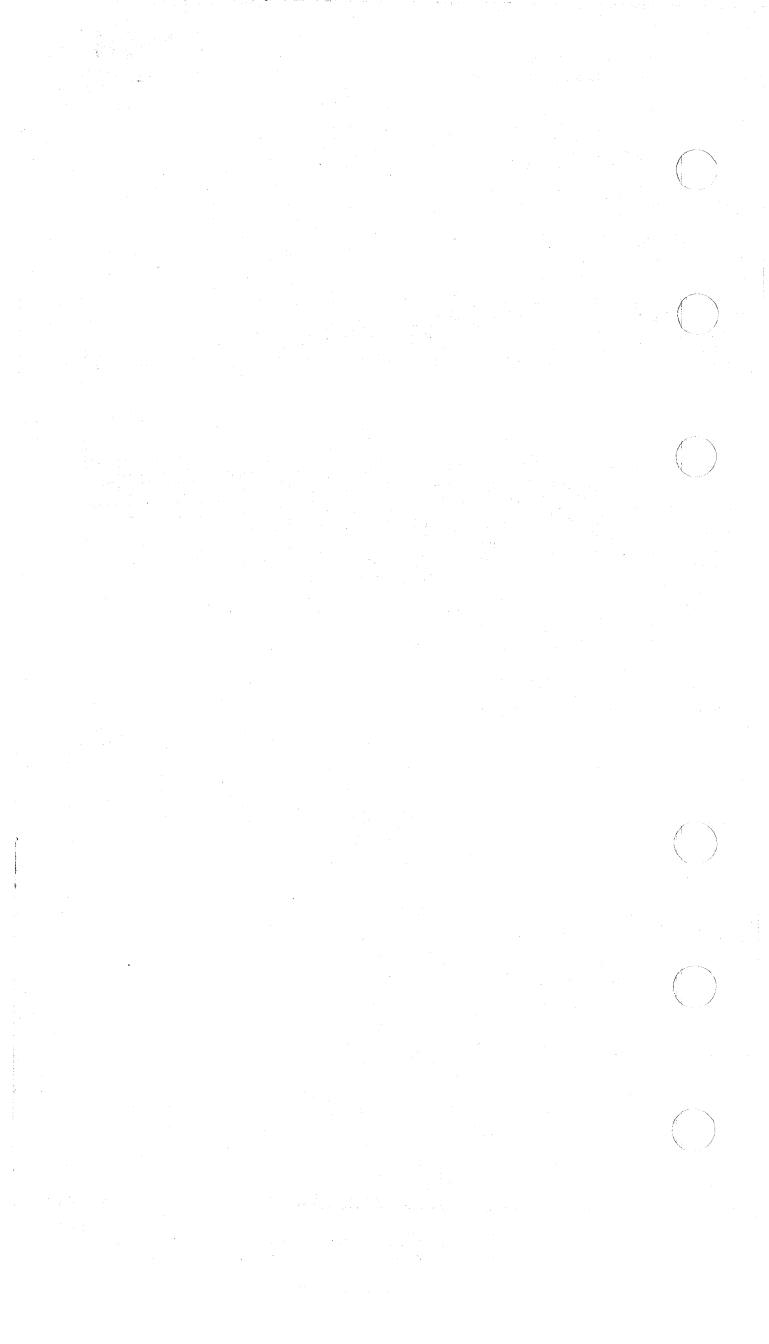
92CS-10720

TYPICAL CHARACTERISTICS



92CS-10721





Power Transistor

GERMANIUM P-N-P ALLOY TYPE

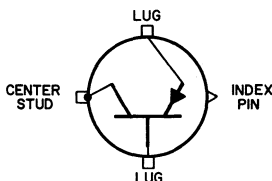
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Seated Length	0.520"
Maximum Diameter.	1.250"
Dimensional Outline	JEDEC No. TO-36
Case.	Welded, Metal
Seals	Hermetic
Terminal Diagram (See <i>Dimensional Outline</i>):	

BOTTOM VIEW



INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and audio-
amplifier, relay- and solenoid-actuating circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter-to-base reverse biased

(DC emitter-to-base volts = -1.5) -50 max. volts

EMITTER-TO-BASE VOLTAGE -30 max. volts

COLLECTOR CURRENT -15 max. amp

EMITTER CURRENT 15 max. amp

BASE CURRENT. -4 max. amp

TRANSISTOR DISSIPATION:^a

At case temperatures^b of 25° C or below. 150 max. watts

CASE-TEMPERATURE^b RANGE:

Operating and storage -65 to +100 °C

Typical Operation:

In a common-emitter, base-input, power-switching
circuit at case temperature^b of 25° C

DC Supply Voltage -12 volts

DC Base-Bias Voltage. 6 volts

"On" DC Collector Current -12 amp

"Turn-On" Base Current. -2 amp

"Turn-Off" Base Current 0 amp

← Indicates a change.



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DATA 1
8-61

2N442

Switching Time:

Rise time	15	μ sec
Fall time	15	μ sec

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

^b Measured at any point on seating surface.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25° C unless otherwise specified

Min. Typical Max.

DC Collector-to-Emitter

Breakdown Voltage:

With base connected to emitter, dc collector

amperes = -0.3. BV_{CES} -45 - - volts

With base open: BV_{CEO}

For dc collector

amperes = -0.3. - -45 - volts

For dc collector

amperes = -1^c. -30 - - volts

DC Base-to-Emitter

Voltage for dc collector-to-emitter volts

= -2, dc collector

amperes = -5. V_{BE} - -0.65 - volt

DC Collector-to-Emitter

Saturation Voltage

for dc collector

amperes = -12, dc base

amperes = -2. $V_{CE(sat)}$ - -0.3 - volt

DC Emitter Voltage for

dc collector volts =

-50, dc emitter current

= 0. V_{EBPT} - - -1 volt

DC Punch-Through Voltage.

for dc emitter volts =

-30, dc collector

current = 0. I_{EBO} - -1 -4 ma

DC Collector-Cutoff

Current:

With dc collector volts

= -2, dc emitter

current = 0. - -100 - μ a

With dc collector volts

= -50, dc emitter

current = 0. - -2 -4 ma

With dc collector volts

= -50, dc emitter

current = 0, case

temperature^b = 71° C. - - -15 ma

→ Indicates a change.



DC Current Transfer Ratio for dc collector-to- emitter volts = -2, dc collector amperes =	h_{FE}			
-5		20	-	40
-12		-	20	-
Beta-Cutoff Frequency for dc collector-to- emitter volts = -6, dc collector amperes = -5	f_{ae}	-	10	-
Thermal Resistance: Junction-to-case	R_T	-	0.35	0.5 °C/watt
Thermal Capacity for pulse duration of 1 to 10 milliseconds		-	0.075	- watt- sec/°C
Thermal Time Constant	τ_1	-	26.25	- msec

^b Measured at any point on seating surface.

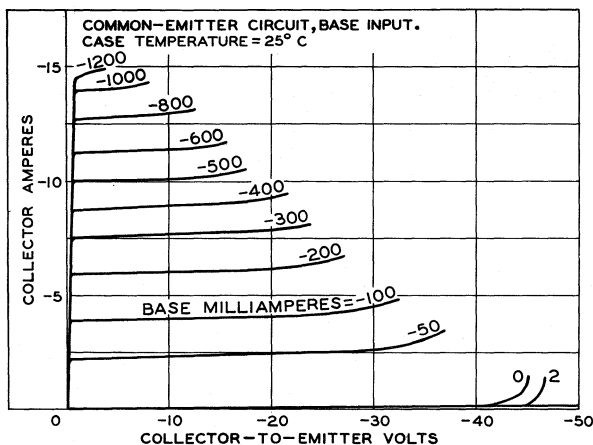
^c Tested by sweep method to prevent excessive heating of collector junction.

PERFORMANCE TESTS,
OPERATING CONSIDERATIONS,
DIMENSIONAL OUTLINE,
SUGGESTED MOUNTING ARRANGEMENT,
RATING CHART,
TYPICAL BASE-CHARACTERISTICS CURVES,
and
TYPICAL CHARACTERISTICS CURVES
 shown under Type 2N441 also apply to the 2N442

← Indicates a change.



TYPICAL COLLECTOR CHARACTERISTICS



92CS-10739



Power Transistor

GERMANIUM P-N-P ALLOY TYPE

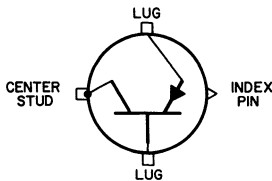
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Seated Length	0.520"
Maximum Diameter.	1.250"
Dimensional Outline	JEDEC No. TO-36
Case.	Welded, Metal
Seals	Hermetic
Terminal Diagram (See <i>Dimensional Outline</i>):	

BOTTOM VIEW



INDUSTRIAL SERVICE

*Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and audio-
amplifier, relay- and solenoid-actuating circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter-to-base reverse biased

(DC emitter-to-base volts = -1.5) . . . -60 max. volts

EMITTER-TO-BASE VOLTAGE -40 max. volts

COLLECTOR CURRENT -15 max. amp

EMITTER CURRENT 15 max. amp

BASE CURRENT. -4 max. amp

TRANSISTOR DISSIPATION:^a

At case temperatures^b of 25°C or below. 150 max. watts

CASE-TEMPERATURE^b RANGE:

Operating and storage -65 to +100 °C

Typical Operation:

*In a common-emitter, base-input, power-
switching circuit at case temperature^b of 25°C*

DC Supply Voltage -12 volts

DC Base-Bias Voltage. 6 volts

"On" DC Collector Current -12 amp

"Turn-On" Base Current. -2 amp

"Turn-Off" Base Current 0 amp

← Indicates a change.



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DATA 1
8-61

Switching Time:

Rise time	15	μsec
Fall time	15	μsec

^a See accompanying Rating Chart and also Transistor-Dissipation Rating Chart in General Section.

^b Measured at any point on seating surface.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25° C unless otherwise specified.
Min. Typical Max.

DC Collector-to-Emitter

Breakdown Voltage:

With base connected to emitter, dc collector

amperes = -0.3 . . .	BV_{CES}	-50	-	-	volts
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With base open:

For dc collector amperes = -0.3 . .	BV_{CEO}	-	-55	-	volts
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For dc collector amperes = -1 ^c . . .		-45	-	-	volts
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DC Base-to-Emitter

Voltage for dc collector-to-emitter

volts = -2, dc collector amperes = -5 . .	V_{BE}	-	-0.65	-0.9	volt
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DC Collector-to-Emitter

Saturation Voltage

for dc collector amperes = -12, dc base

amperes = -2	$V_{CE(sat)}$	-	-0.3	-1	volt
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DC Emitter Voltage for dc collector volts = -60,

dc emitter current = 0.	V_{EB}	-	-	-1	volt
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DC Punch-Through Voltage.

	V_{PT}	-60	-	-	volts
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DC Emitter-Cutoff Current

for dc emitter volts = -40, dc collector

current = 0	I_{EBO}	-	-1	-4	ma
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DC Collector-Cutoff

Current:

With dc collector volts = -2, dc emitter

current = 0	I_{CBO}	-	-100	-	μa
-----------------------	-----------	---	------	---	---------------

With dc collector volts = -60, dc emitter

current = 0		-	-2	-4	ma
-----------------------	--	---	----	----	----

With dc collector volts = -60, dc emitter

current = 0, case temperature ^b = 71° C .		-	-	-15	ma
--	--	---	---	-----	----

→ Indicates a change.



DC Current Transfer Ratio for dc collector-to-emitter volts = -2, dc collector amperes =	h_{FE}			
-5		20	-	40
-12		-	20	-
Beta-Cutoff Frequency for dc collector-to-emitter volts = -6, dc collector amperes = -5	f_{ae}	-	10	- kc
Thermal Resistance: Junction-to-case . . .	R_T	-	0.35	0.5 °C/watt
Thermal Capacity for pulse duration of 1 to 10 milliseconds		-	0.075	- watt-sec/°C
Thermal Time Constant . .	τ_1	-	26.25	- msec

^b Measured at any point on seating surface.

^c Tested by sweep method to prevent excessive heating of collector junction.

←

PERFORMANCE TESTS,
OPERATING CONSIDERATIONS,
DIMENSIONAL OUTLINE,
SUGGESTED MOUNTING ARRANGEMENT,
RATING CHART,
TYPICAL BASE-CHARACTERISTICS CURVES,
and
TYPICAL CHARACTERISTICS CURVES
shown under Type 2N441 also apply to the 2N443

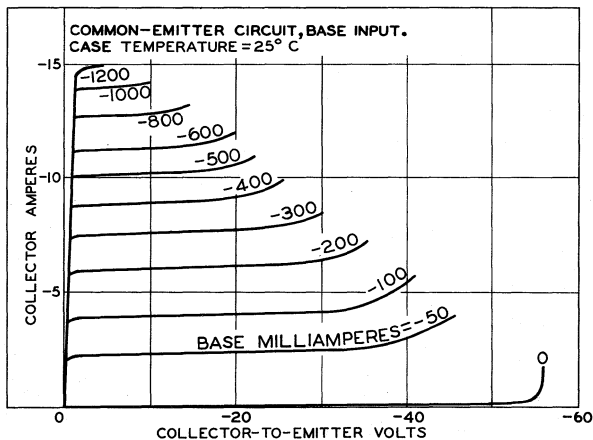
← Indicates a change.



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DATA 2
8-61

TYPICAL COLLECTOR CHARACTERISTICS



92CS-10729

Transistor

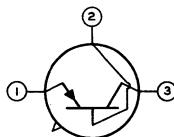
GERMANIUM P-N-P ALLOY-JUNCTION TYPE
For Computer Switching Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-5
Case.	Welded, Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1—Emitter
Lead 2—Base



Lead 3—Collector

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	-18 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With dc emitter-to-base		
volts = -1.	-15 max.	volts
EMITTER-TO-BASE VOLTAGE	-10 max.	volts
COLLECTOR CURRENT	-100 max.	ma
EMITTER CURRENT	100 max.	ma
TRANSISTOR DISSIPATION: ^a		
At ambient temperature of 25° C or below.	150 max.	mW
At ambient temperature of 55° C	75 max.	mW
At ambient temperature of 71° C	35 max.	mW
AMBIENT-TEMPERATURE RANGE:		
Operating	-65 to +85	°C
Storage	-65 to +100	°C
LEAD TEMPERATURE:		
For 10 seconds maximum.	255 max.	°C

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

← Indicates a change.



RADIO CORPORATION OF AMERICA
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DATA 1
6-61

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless otherwise specified. Ambient temperature of 25° C.

Min. Typical Max.

DC Collector Breakdown Voltage for dc collector ma. = -0.02, dc emitter ma. = 0.	BV_{CBO}	-18	-30	-	volts
DC Punch-Through Voltage for dc emitter volts = -1.	V_P	-15	-25	-	volts
DC Emitter Breakdown Voltage for dc emitter ma. = -0.02, dc collector ma. = 0.	BV_{EBO}	-10	-25	-	volts
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = -20, dc base ma. = -1.	$V_{CE(sat)}$	-0.2	-0.3	-	volt
DC Base-to-Emitter Saturation Voltage for dc collector ma. = -20, dc base ma. = -1.	$V_{BE(sat)}$	-	-0.35	-0.5	volt
DC Collector-Cutoff Current for dc collector volts = -12, dc emitter ma. = 0.	I_{CBO}	-	-3	-10	μa
DC Emitter-Cutoff Current for dc emitter volts = -2.5, dc collector ma. = 0.	I_{EBO}	-	-1	-	μa
Collector-to-Base Capacitance for dc collector volts = -6, dc collector ma. = 0.	C_{ob}	-	12	20	$\mu\mu f$
DC Current Transfer Ratio for dc collector-to-emitter volts = -0.3, dc collector ma. = -20	h_{FE}	20	30	-	
Alpha-Cutoff Frequency for dc collector volts = -6, dc collector ma. = -1	f_{ab}	4	8	-	Mc
Stored Base Charge for dc collector ma. = -20, dc base ma. = -2.	Q_S	-	1700	2400	$\mu\mu\text{coulombs}$
Thermal Time Constant	τ_1	-	10	-	msec
Thermal Resistance: Junction-to-free air.	R_T	-	-	500	°C/watt

→ Indicates a change.



PERFORMANCE TESTS

This transistor type is tested in accordance with Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

← Indicates a change.

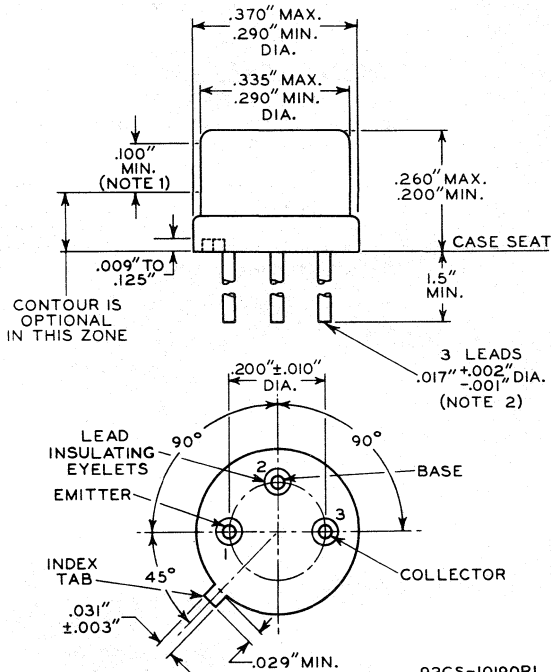


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Semiconductor & Materials Division
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DATA 2
6-61

2N581

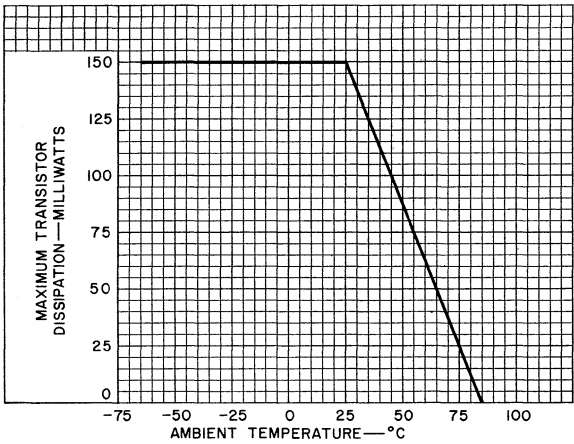
JEDEC No. T0-5



NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

RATING CHART



92CS-10907RI



Transistor

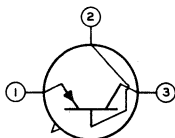
GERMANIUM P-N-P ALLOY-JUNCTION TYPE
For Computer Switching Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. T0-5
Case.	Welded, Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector

SWITCHING SERVICE

Maximum and Minimum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	-25 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With dc emitter-to-base volts = -1.	-14 max.	volts
EMITTER-TO-BASE VOLTAGE	-12 max.	volts
COLLECTOR CURRENT	-100 max.	ma
EMITTER CURRENT	100 max.	ma
TRANSISTOR DISSIPATION: ^a		
At ambient temperature of 25° C or below.	150 max.	mw
At ambient temperature of 55° C	75 max.	mw
At ambient temperature of 71° C	35 max.	mw
AMBIENT-TEMPERATURE RANGE:		
Operating	-65 to +85	°C
Storage	-65 to +100	°C
LEAD TEMPERATURE:		
For 10 seconds maximum.	255 max.	°C

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

← Indicates a change.



ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at ambient temperature of 25°C unless otherwise specified

Min. Typical Max.

DC Collector Breakdown					
Voltage for dc collector ma. = -0.02,					
dc emitter ma. = 0. BV _{CBO}					
	-25	-30	-		volts
DC Punch-Through Voltage for dc emitter					
volts = -1. V _P					
	-14	-30	-		volts
DC Emitter Breakdown					
Voltage for dc emitter ma. = -0.02, dc					
collector ma. = 0 BV _{EBO}					
	-12	-30	-		volts
DC Collector-to-Emitter Saturation Voltage: V _{CE}					
With dc collector ma. (sat)					
= -24, dc base ma.					
= -0.6.					
	-	-0.12	-0.2		volt
With dc collector ma.					
= -100, dc base ma.					
= -5.					
	-	-0.2	-0.3		volt
DC Base-to-Emitter Saturation Voltage: V _{BE}					
With dc collector ma. (sat)					
= -24, dc base ma.					
= -0.6.					
	-	-0.3	-0.4		volt
With dc collector ma.					
= -100, dc base ma.					
= -5.					
	-	-0.6	-0.8		volt
DC Collector-Cutoff Current I _{CBO}					
rent for dc collector					
volts = -12, dc emitter					
ma. = 0, ambient					
temperature =					
25°C					
	-	-2	-5		μa
80°C					
	-	-45	-90		μa
DC Emitter-Cutoff Current					
for dc emitter volts =					
-2.5, dc collector ma.					
= 0 I _{EBO}					
	-	-1	-		μa
Collector-to-Base Capacitance for dc collector					
volts = -6, dc collector					
ma. = 0. C _{ob}					
	-	12	20		μf
DC Current Transfer Ratio: h _{FE}					
With dc collector-to-					
emitter volts = -0.2,					
dc collector ma. =					
-24					
	40	60	-		

→ Indicates a change.

With dc collector-to-emitter volts = -0.3,
dc collector ma. =
-100.

Alpha-Cutoff Frequency for dc collector volts = -6, dc collector ma. = -1.	f_{ab}	20	25	-	
Stored Base Charge for dc collector ma. = -24, dc base ma. = -1.2	Q_S	14	18	-	Mc
Thermal Time Constant . .	τ_I	-	800	1200	$\mu\text{coulombs}$
Thermal Resistance: Junction-to-free air. .	R_T	-	10	-	msec
		-	-	500	$^{\circ}\text{C/watt}$

PERFORMANCE TESTS

This transistor type is tested in accordance with Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

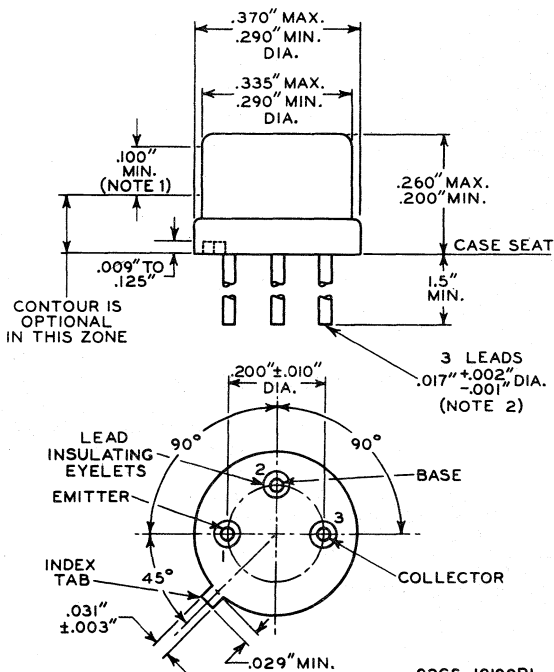
It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

← Indicates a change.



JEDEC No. TO-5

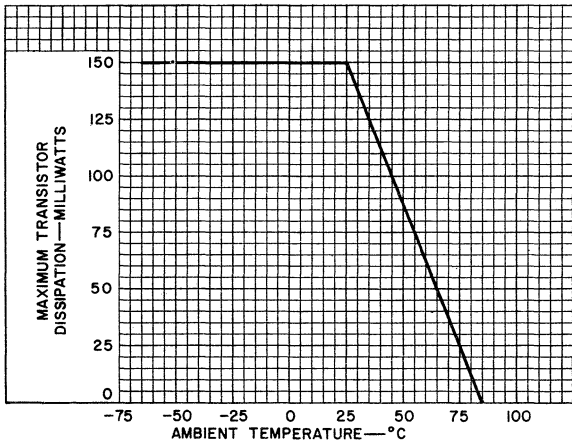


92CS-10190RI

NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

RATING CHART



92CS-10907RI





2N585

2N585

JUNCTION TRANSISTOR

GERMANIUM N-P-N ALLOY TYPE

For "on-off" control applications

GENERAL DATA

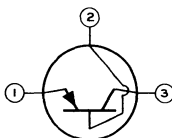
Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JETEC No. T0-9
Case.	Metal
Envelope Seals.	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline
Base.	JETEC No. E3-51

BOTTOM VIEW

Lead 1 - Emitter

Lead 3 - Collector



Lead 2 - Base

SWITCHING SERVICE

Maximum Ratings, Absolute Values:

COLLECTOR-TO-BASE VOLTAGE	25 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE.	24 max.	volts
EMITTER-TO-BASE VOLTAGE	20 max.	volts
COLLECTOR CURRENT	200 max.	ma
EMITTER CURRENT	-200 max.	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C	120 max.	mW
At ambient temperature of 55° C	45 max.	mW
At ambient temperature of 71° C	10 max.	mW
AMBIENT TEMPERATURE (During operation). . .	71 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base unless otherwise specified, and ambient temperature = 25° C

	Typical Values	Range Values	
		Min.	Max.
Collector Breakdown Voltage (BV _{CB0}) with collector μ a = 25, and emitter current = 0	40	25	- volts



2N585

JUNCTION TRANSISTOR

	Typical Values	Range Values	
		Min.	Max.
Emitter Breakdown Voltage (BV_{EBO}) with emitter μa = 25, and collector current = 0	40	20	- volts
Collector-to-Emitter Punch-Through Voltage (V_P) with emitter volts = 1, and emitter current = 0	40	24	- volts
Collector-to-Emitter Saturation Voltage (V_{CE}) with collector ma. = 20, and base ma. = 1	0.1	-	0.2 volt
Base-to-Emitter Saturation Voltage (V_{BE}) with collector ma. = 20, and base ma. = 1	0.35	-	0.45 volt
Collector-Cutoff Current (I_{CBO}):			
With collector volts = 0.25, and emitter current = 0	3	-	6 μa
With collector volts = 12, and emitter current = 0	4	-	8 μa
Emitter-Cutoff Current (I_{EBO}) with emitter volts = 5, and collector current = 0	1.5	-	5 μa
DC Current Transfer Ratio (h_{FE}) with collector-to-emitter volts = 0.2, and collector ma. = 20	40	20	-
Alpha-Cutoff Frequency ($f_{\alpha b}$) with collector volts = 6, and collector ma. = 1	5	3	- Mc
Collector-to-Base Capacitance (C_{ob}) with collector volts = 10, and emitter ma. = -1	12	-	20 $\mu\mu f$

OPERATING CONSIDERATIONS

The 2N585 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N585 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

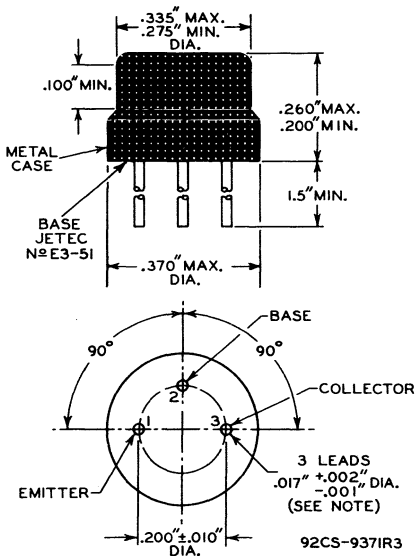


2N585

2N585

JUNCTION TRANSISTOR

When dip soldering is employed in the assembly of printed circuitry using the 2N585, the temperature of the solder should not exceed 230°C for a maximum immersion period of 10 seconds.



NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.050''$ AND $0.250''$ FROM THE BASE SEAT. BETWEEN $0.250''$ AND $1.50''$ A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.





2N586

2N586

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

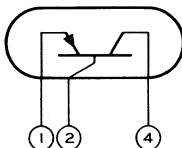
For "on-off" control applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.375"
Maximum Diameter.	0.360"
Case.	Metal
Envelope Seals.	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline

Lead 1 - Emitter



Lead 4 - Collector

Lead 2 - Base

SWITCHING SERVICE

Maximum Ratings, Absolute Values:

COLLECTOR-TO-BASE VOLTAGE	-45 max.	volts
EMITTER-TO-BASE VOLTAGE	-12 max.	volts
COLLECTOR CURRENT	-250 max.	ma
EMITTER CURRENT	250 max.	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C	250 max.	mw
At ambient temperature of 55° C	125 max.	mw
At ambient temperature of 71° C	60 max.	mw
AMBIENT TEMPERATURE (During operation).	85 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base unless otherwise specified, and ambient temperature = 25° C

	Typical Values	Range Values	
		Min.	Max.
Collector-to-Emitter Break- down Voltage:			
With collector ma. = -1, and base ma. = 0 (BV_{CEO}).	-35	-25	-
With collector $\mu a = -50$, and base-to-emitter volts = 0 (BV_{CES})	-70	-45	-

← Indicates a change.

2N586



2N586

JUNCTION TRANSISTOR

	Typical Values	Range Values		
		Min.	Max.	
Collector-to-Emitter Punch-Through Voltage (V_P) with emitter volts = -1, and emitter current = 0	-75	-45	-	volts
Collector-to-Emitter Saturation Voltage (V_{CE}) with collector ma. = -250, and base ma. = -25.	-0.25	-	-0.5	volt
→ Base-to-Emitter Voltage (V_{BE}) with collector ma. = -250, and base ma. = -7.	-0.7	-	-1	volt
Collector-Cutoff Current (I_{CBO}) with collector volts = -45, and emitter current = 0	-8	-	-16	μa
Emitter-Cutoff Current (I_{EBO}) with emitter volts = -12, and collector current = 0	-4	-	-12	μa
DC Current Transfer Ratio (h_{FE}) with collector-to-emitter volts = -0.5, and collector ma. = -250.	55	35	-	

OPERATING CONSIDERATIONS

The 2N586 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N586 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N586, the temperature of the solder should not exceed 230° C for a maximum immersion period of 10 seconds.

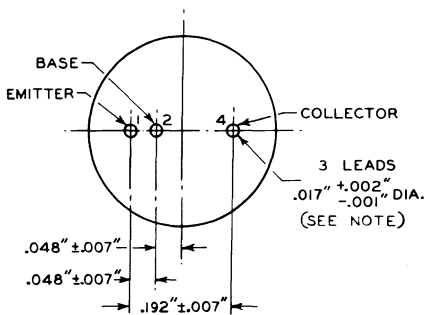
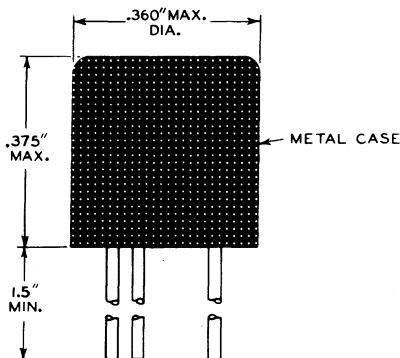
→ Indicates a change.



2N586

2N586

JUNCTION TRANSISTOR



92CS-9176R3

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50" A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.





2N591

2N591

JUNCTION TRANSISTOR

GERMANIUM P-N-P ALLOY TYPE

For audio-frequency driver-amplifier applications

GENERAL DATA

Electrical:

Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = -1 with emitter open, and at ambient temperature of 25° C	-7	μ a
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = -1 with collector open, and at ambient temperature of 25° C	-20	μ a
Junction-Temperature Rise:		
In free air	0.34	°C/mw
With heat sink	0.15	°C/mw

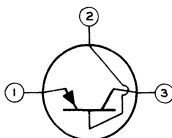
Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.405"
Maximum Diameter.	0.240"
Dimensional Outline	JETEC No. T0-1
Case.	Metal
Envelope Seals.	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline
Base.	JETEC No. E3-39

BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector
(Adjacent
to red dot
on side of
case)

AUDIO-FREQUENCY DRIVER-AMPLIFIER — Class A

Maximum Ratings, Absolute Values:

PEAK COLLECTOR-TO-EMITTER VOLTAGE	-32	max.	volts
PEAK COLLECTOR CURRENT.	-40	max.	ma
DC COLLECTOR CURRENT.	-20	max.	ma
PEAK EMITTER CURRENT.	40	max.	ma
DC EMITTER CURRENT.	20	max.	ma



2N591

JUNCTION TRANSISTOR

COLLECTOR DISSIPATION:

For continuous operation:

At ambient temperatures up to 55° C:

In free air.	50	max.	mw
With heat sink	100	max.	mw

At ambient temperature of 71° C:

In free air.	20	max.	mw
With heat sink	40	max.	mw

For intermittent operation:

At ambient temperatures up to 100° C:

In free air.	75	max.	mw
With heat sink	150	max.	mw

AMBIENT TEMPERATURE (During operation):

For continuous operation	71	max.	°C
For intermittent operation	100	max.	°C

STORAGE-TEMPERATURE RANGE	-65 to +85		°C
-------------------------------------	------------	--	----

Characteristics, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage.	-12	volts
DC Emitter Current	2	ma
Current Transfer Ratio [■]	-70	
Alpha-Cutoff Frequency	0.7	Mc

Typical Operation, At Ambient Temperature of 25° C:

DC Supply Voltage.	-14.4	volts
DC Collector-to-Emitter Voltage.	-12	volts
DC Base-to-Emitter Voltage	-0.13	volt
DC Collector Current	-2	ma
Signal Frequency	1	kc
Input Resistance	1000	ohms
Output Resistance.	10000	ohms
Power Gain [▲]	41	db
Total Harmonic Distortion.	3	%
Power Output	5	mw
Transistor Dissipation	25	mw

- This rating is limited to conditions where the ambient temperature approaches but does not exceed 100° C for only occasional periods of several hours each during the operation of the equipment. In order to assure that this intermittent dissipation rating is not exceeded, it is essential that the sum of the emitter and collector dc resistances be chosen such that the maximum power transfer from the supply to the transistor is limited to 75 milliwatts without a heat sink or 150 milliwatts with a heat sink. For a 16-volt supply, the sum of these resistances should be 850 ohms to limit the power transfer to 75 milliwatts, or 425 ohms to limit the power transfer to 150 milliwatts.

■ Measured at 1 kc.

▲ Measured at primary of driver transformer.



2N591

JUNCTION TRANSISTOR

2N591

OPERATING CONSIDERATIONS

The 2N591 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N591 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise the heat of the soldering operation will crack the seals of the leads and damage the transistor.

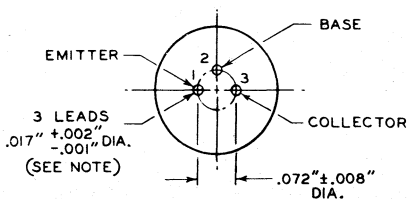
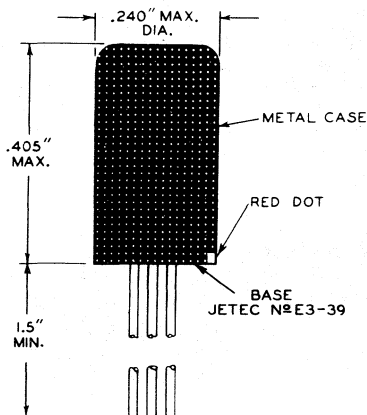
When dip soldering is employed in the assembly of printed circuitry using the 2N591, the temperature of the solder should not exceed 255°C for a maximum immersion period of 10 seconds.

2N591



2N591

JUNCTION TRANSISTOR



92CS-9148R3

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



2N647

2N647

JUNCTION TRANSISTOR

GERMANIUM N-P-N ALLOY TYPE

For large-signal audio-frequency applications

GENERAL DATA

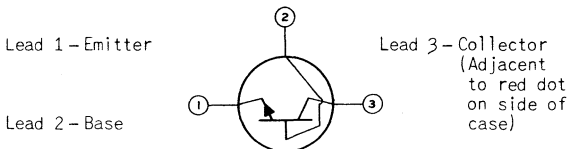
Electrical, At Ambient Temperature of 25° C:

Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = 25 with emitter open.	14	μ a
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = 12 with collector open.	14	μ a

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.405"
Maximum Diameter.	0.240"
Dimensional Outline	JEDEC No. TO-1
Case.	Metal
Envelope Seals.	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline

BOTTOM VIEW



AUDIO-FREQUENCY AMPLIFIER — Class A & Class B

Maximum Ratings, Absolute-Maximum Values:

PEAK COLLECTOR-TO-BASE VOLTAGE.	25 max.	volts
PEAK COLLECTOR-TO-EMITTER VOLTAGE	25 max.	volts
PEAK EMITTER-TO-BASE VOLTAGE.	12 max.	volts
PEAK COLLECTOR CURRENT.	100 max.	ma
DC COLLECTOR CURRENT.	50 max.	ma
PEAK EMITTER CURRENT.	-100 max.	ma
DC EMITTER CURRENT.	-50 max.	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C	100 max.	mw
At ambient temperature of 55° C	50 max.	mw
At ambient temperature of 71° C	20 max.	mw
AMBIENT TEMPERATURE (During operation). . .	71 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C



2N647

JUNCTION TRANSISTOR

Characteristics, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage	1	volt
DC Collector Current	50	ma
DC Current Gain	70	

Typical Operation:*In accompanying class B complementary-symmetry circuit, and at ambient temperature of 25° C*

DC Supply Voltage	6	volts
DC Collector-to-Emitter Voltage for driver stage	2.3	volts
Zero-Signal DC Base-to-Emitter Voltage for output stage	0.14	volt
Zero-Signal DC Collector Current for each transistor (Driver and output stage)	1.5	ma
Peak Collector Current for each transistor in output stage	70	ma
Input Resistance	1100	ohms
Load Resistance	45	ohms
Signal Frequency	1	kc
Power Gain	54	db
Power Output with input of 20 millivolts	100	mw
Total Harmonic Distortion with power output of 100 milliwatts	10 max.	%

OPERATING CONSIDERATIONS

The 2N647 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

In class B service, when the 2N647 is operated at ambient temperatures other than 25° C, the base-to-emitter voltage should be reduced or increased by approximately 0.002 volt for each degree the ambient temperature is above or below 25° C, respectively. When this transistor is operated under varying ambient temperatures, some form of temperature compensation may be used in the base-to-emitter circuit to hold the operating point constant.

The *flexible leads* of the 2N647 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N647, the temperature of the solder should not exceed 255° C for a maximum immersion period of 10 seconds.



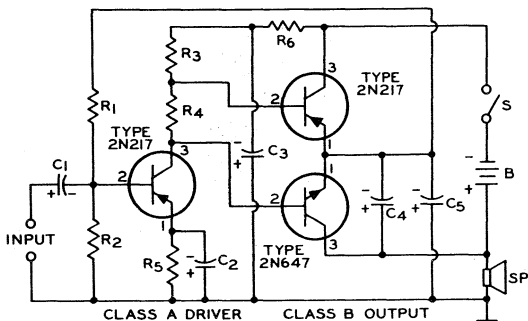
2N647

JUNCTION TRANSISTOR

2N647

AUDIO-AMPLIFIER CIRCUIT

Utilizing Type 2N217 as Class A Driver for Types 2N217 and 2N647 in Class B Complementary-Symmetry Output Stage



92CS-9843

- B: 6 volts
C₁: 5 μ f, electrolytic, 6 volts
C₂, C₃: 0.5 μ f, electrolytic, 6 volts
C₄: 0.5 μ f, electrolytic, 6 volts
C₅: 50 μ f, electrolytic, 6 volts
R₁: 12,000 ohms, 0.5 watt
R₂: 8200 ohms, 0.5 watt
R₃: 1500 ohms, 0.5 watt
R₄: 180 ohms, 0.5 watt
R₅: 560 ohms, 0.5 watt
R₆: 330 ohms, 0.5 watt
S: Switch
SP: Speaker, 45-ohm voice coil

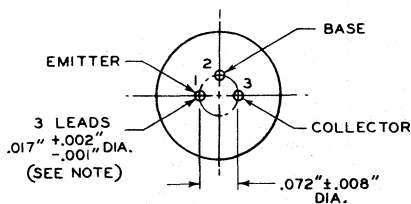
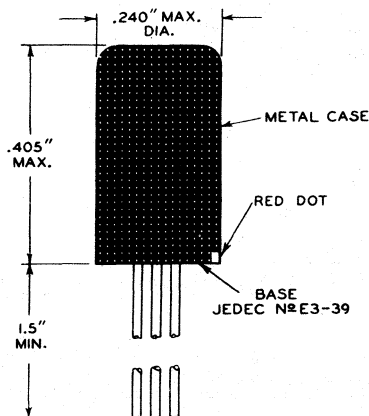
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2N647



2N647

JUNCTION TRANSISTOR



92CS-9148R4

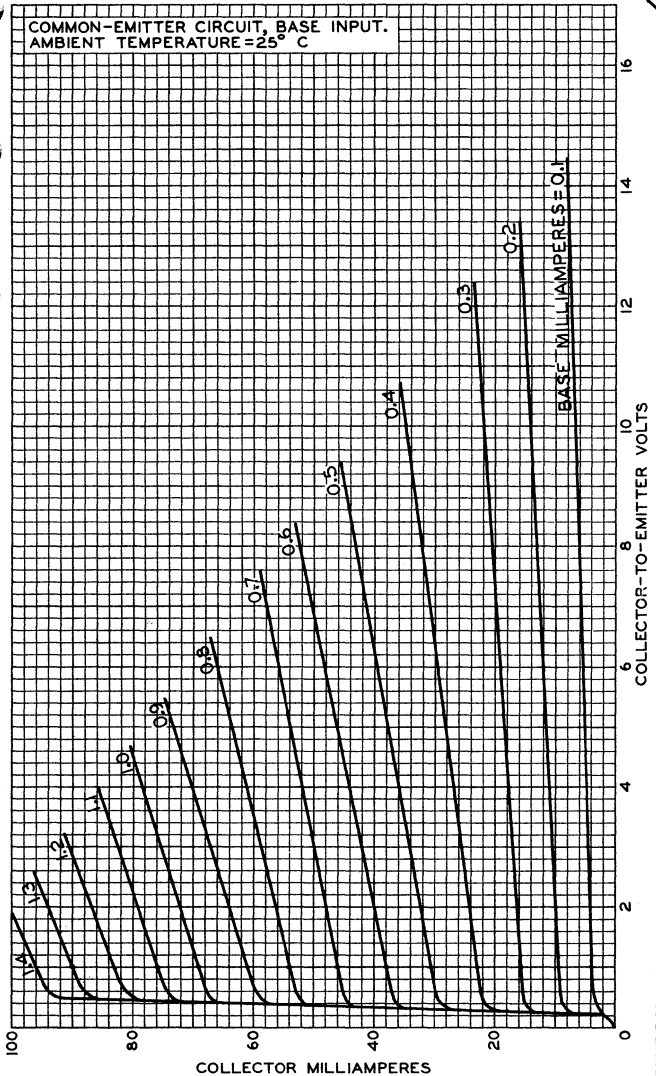
NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



2N647

2N647

AVERAGE COLLECTOR CHARACTERISTICS

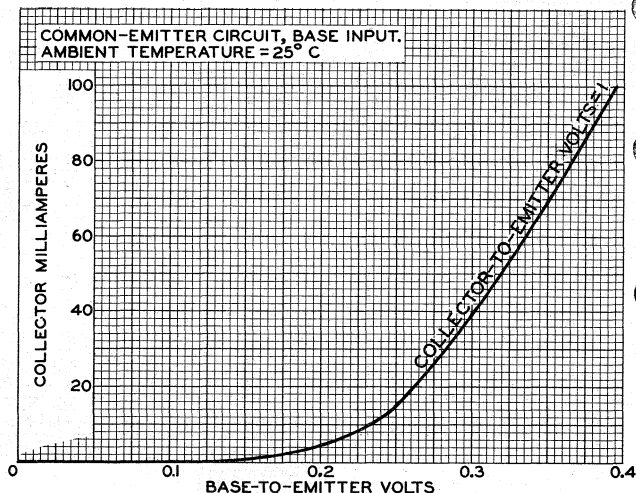


2N647

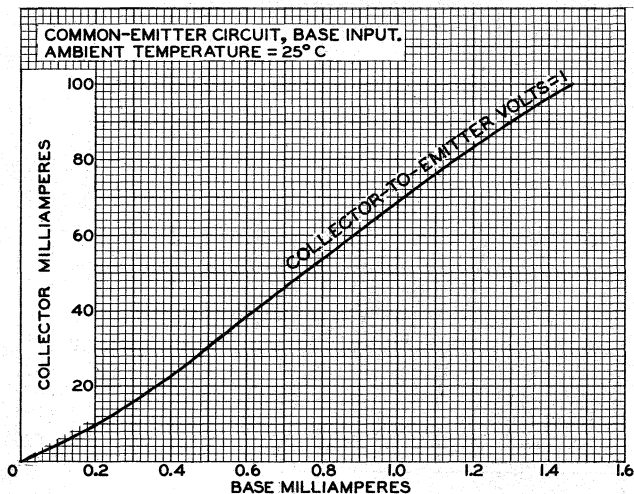


2N647

AVERAGE CHARACTERISTICS



92CS-9846

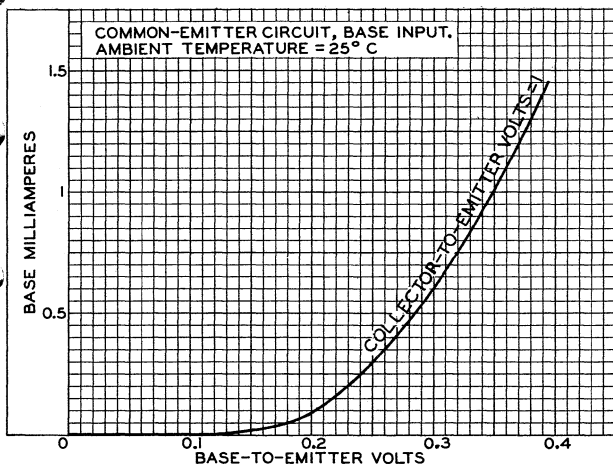




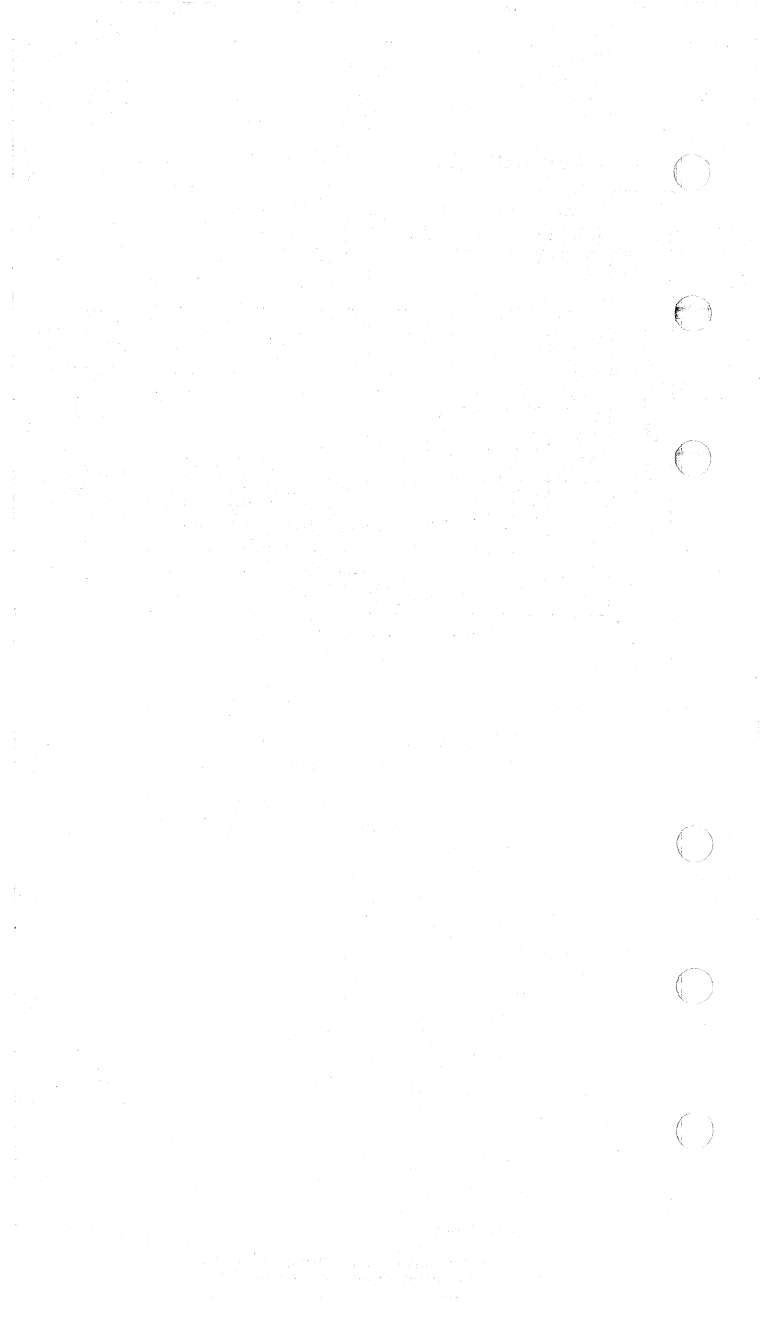
2N647

2N647

AVERAGE BASE CHARACTERISTIC



92CS-9845





2N649

2N649

JUNCTION TRANSISTOR

GERMANIUM N-P-N ALLOY TYPE

For large-signal audio-frequency applications

GENERAL DATA

Electrical, At Ambient Temperature of 25° C:

Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = 12 with emitter open.	14	μa
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = 2.5 with collector open.	14	μa

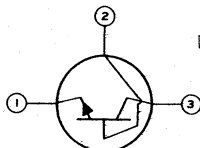
Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.405"
Maximum Diameter.	0.240"
Dimensional Outline	JEDEC No. TO-1
Case.	Metal
Envelope Seals.	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline
Base.	JEDEC No. E3-39

BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector
(Adjacent
to red dot
on side of
case)

AUDIO-FREQUENCY AMPLIFIER — Class A & Class B

Maximum Ratings, Absolute-Maximum Values:

PEAK COLLECTOR-TO-BASE VOLTAGE.	20 max.	volts
PEAK COLLECTOR-TO-EMITTER VOLTAGE	18 max.	volts
PEAK EMITTER-TO-BASE VOLTAGE.	2.5 max.	volts
PEAK COLLECTOR CURRENT.	100 max.	ma
DC COLLECTOR CURRENT.	50 max.	ma
PEAK EMITTER CURRENT.	-100 max.	ma
DC EMITTER CURRENT.	-50 max.	ma
COLLECTOR DISSIPATION:		
At ambient temperature of 25° C	100 max.	mw
At ambient temperature of 55° C	50 max.	mw
At ambient temperature of 71° C	20 max.	mw
AMBIENT TEMPERATURE (During operation).	71 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C



2N649

JUNCTION TRANSISTOR

Characteristics, At Ambient Temperature of 25° C:*Common-Emitter Circuit, Base Input*

DC Collector-to-Emitter Voltage	1	volt
DC Collector Current	50	ma
DC Current Gain	65	

Typical Operation:

In accompanying class B complementary-symmetry circuit, and at ambient temperature of 25° C

DC Supply Voltage	6	volts
DC Collector-to-Emitter Voltage for driver stage.	2.3	volts
Zero-Signal DC Base-to-Emitter Voltage for output stage.	0.14	volt
Zero-Signal DC Collector Current for each transistor (Driver and output stage)	1.5	ma
Peak Collector Current for each transistor in output stage.	70	ma
Input Resistance	1100	ohms
Load Resistance	45	ohms
Signal Frequency	1	kc
Power Gain	54	db
Power Output with input of 20 millivolts.	100	mw
Total Harmonic Distortion with power output of 100 milliwatts	10 max.	%

OPERATING CONSIDERATIONS

The 2N649 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

In class B service, when the 2N649 is operated at ambient temperatures other than 25° C, the base-to-emitter voltage should be reduced or increased by approximately 0.002 volt for each degree the ambient temperature is above or below 25° C, respectively. When this transistor is operated under varying ambient temperatures, some form of temperature compensation may be used in the base-to-emitter circuit to hold the operating point constant.

The *flexible leads* of the 2N649 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N649, the temperature of the solder should not exceed 255° C for a maximum immersion period of 10 seconds.



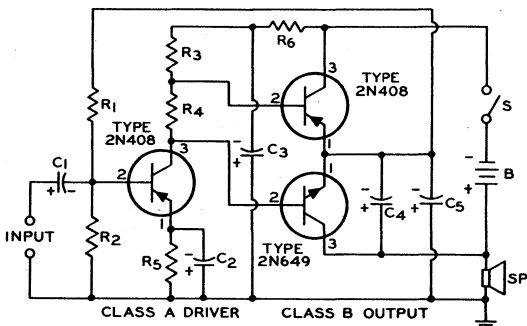
2N649

2N649

JUNCTION TRANSISTOR

AUDIO-AMPLIFIER CIRCUIT

Utilizing Type 2N408 as Class A Driver for Types 2N408 and 2N649 in Class B Complementary-Symmetry Output Stage



92CS-10059

- B: 6 volts
 C₁: 5 μ f, electrolytic, 6 volts
 C₂, C₃: 50 μ f, electrolytic, 6 volts
 C₄: 0.5 μ f, electrolytic, 6 volts
 C₅: 50 μ f, electrolytic, 6 volts
 R₁: 12,000 ohms, 0.5 watt
 R₂: 8200 ohms, 0.5 watt
 R₃: 1500 ohms, 0.5 watt
 R₄: 180 ohms, 0.5 watt
 R₅: 560 ohms, 0.5 watt
 R₆: 330 ohms, 0.5 watt
 S: Switch
 SP: Speaker, 45-ohm voice coil

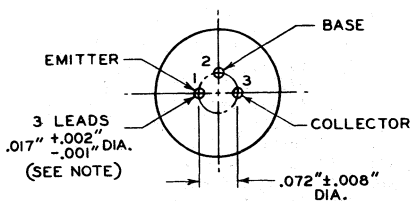
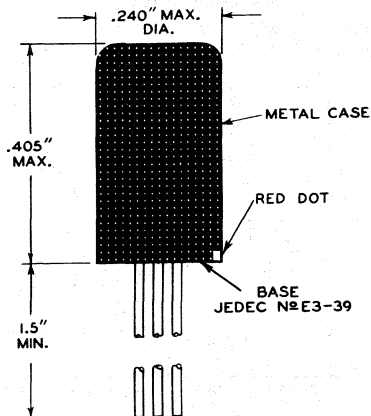
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2N649



2N649

JUNCTION TRANSISTOR



92CS-9148R4

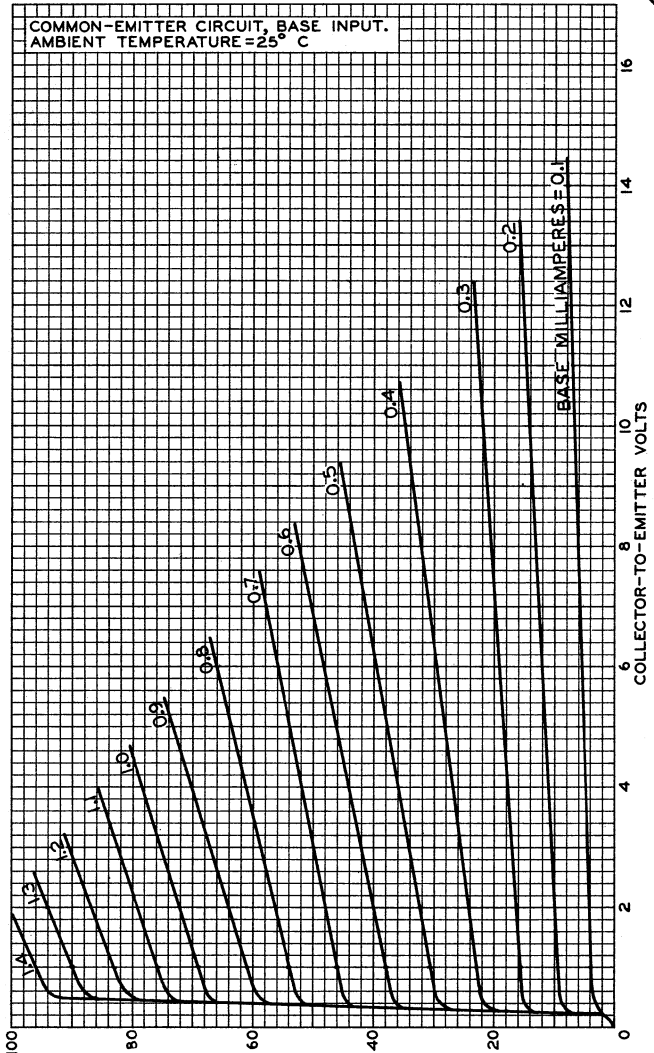
NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



2N649

2N649

AVERAGE COLLECTOR CHARACTERISTICS



SEMICONDUCTOR and MATERIALS DIVISION
RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

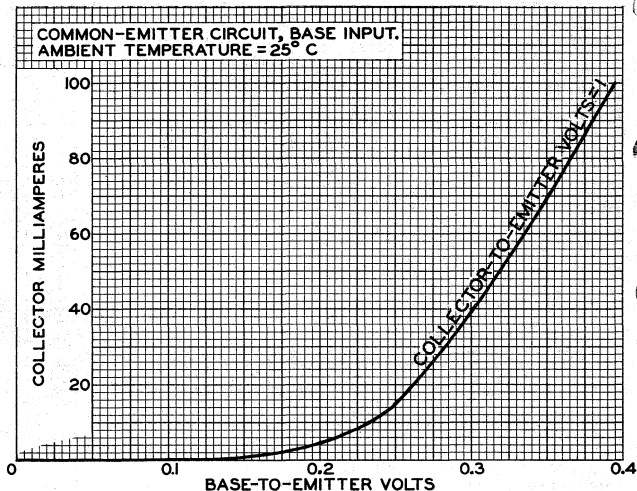
92CM-9844

2N649

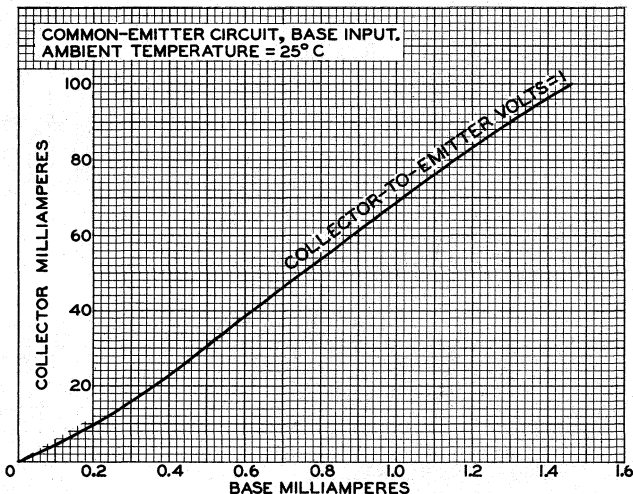


2N649

AVERAGE CHARACTERISTICS



92CS-9846



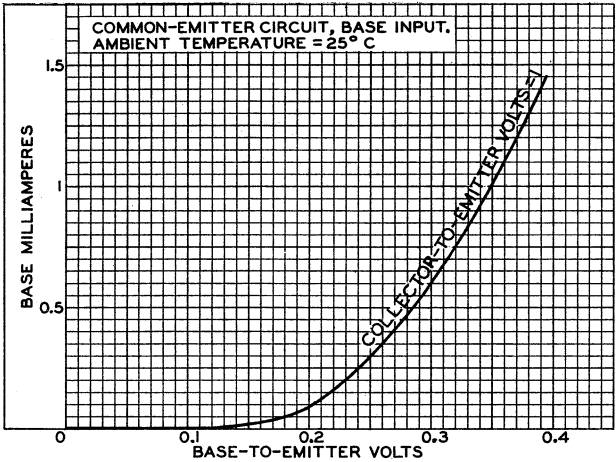
92CS-9847



2N649

2N649

AVERAGE BASE CHARACTERISTIC



92CS-9845



Silicon Controlled-Rectifier

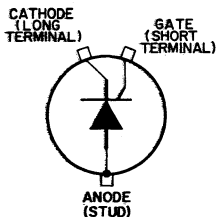
N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

GENERAL DATA

Mechanical:

Dimensions. See Outline T0-48 in General Section
Terminal Diagram:



The arrow indicates direction of forward (easy) current flow as indicated by dc ammeter.

Maximum and Minimum Ratings, Absolute-Maximum Values:

Unless otherwise specified, for sinusoidal ac supply voltage at a frequency between 50 and 400 cps, with resistive or inductive load

PEAK REVERSE VOLTAGE (With gate open):

Repetitive.	$V_{RM}(\text{rep})$	25 max. volts
Non-repetitive (Transient) for duration of 5 milli- seconds maximum	$V_{RM}(\text{non-rep})$	35 max. volts

PEAK FORWARD BLOCKING VOLTAGE (Repetitive):

With gate open.	$V_{FBOM}(\text{rep})$	25 max. volts
-------------------------	------------------------	---------------

AVERAGE FORWARD CURRENT:

At case temperatures:^a

From -65° to 65° C and a
conduction angle of 180° .
Above 65° C and at other
conduction angles.

I_{FAV}	16 max. amp
I_{FAV}	See Average-Forward Current Rating Chart

PEAK SURGE CURRENT in single phase, 60 cps, resistive load operation:^b

For one cycle of applied voltage	$i_{FM}(\text{surge})$	150 max. amp
For more than one cycle of applied voltage	$i_{FM}(\text{surge})$	See Peak-Surge-Current Rating Chart



PEAK GATE VOLTAGE (With anode open):

Forward	V_{GKM}	10 max.	volts
Reverse	V_{KGM}	5 max.	volts
PEAK FORWARD GATE CURRENT	I_{GKM}	2 max.	amp
PEAK GATE POWER	P_{GM}	5 max.	watts
AVERAGE GATE POWER.	P_{GAV}	0.5 max.	watt

TEMPERATURE:

Operating (Case) ^a	$T_C(OPR)$	-65 to 125	°C
Operating (Free-air).	$T_{FA}(OPR)$	See <i>Operation Guidance Chart</i>	
Storage	T_{STG}	-65 to 150	°C

^a Measured at the center of any of the six major faces on the perimeter of the hexagonal flange.

^b Superimposed on device operating within the maximum voltage, average-forward current, gate power, and temperature ratings and may be repeated after sufficient time has elapsed for the device to return to the pre-surge thermal-equilibrium conditions.

ELECTRICAL AND THERMAL CHARACTERISTICS

Unless otherwise specified, at maximum electrical ratings and at indicated case temperatures^a

Min. Typ. Max.

Forward Breakover Voltage at case temperature = 125° C, gate open	V_{BOO}	25	-	-	volts
Average Forward Voltage Drop for one complete cycle in single-phase, 60 cps, resistive load, case temperature = 65° C, gate open.	V_{FAV}	-	-	0.86	volt
Average Blocking Current for one complete cycle, case temperature = 125° C, gate open:					
Forward	I_{FBOAV}	-	-	6.5	ma
Reverse	I_{RBOAV}	-	-	6.5	ma
DC Gate-Trigger Voltage with anode at +6 volts with respect to cathode, case temperature of:					
-65° C.	V_{GT}	-	-	3	volts
125° C.	V_{GT}	0.25	-	-	volt
DC Gate-Trigger Current with anode at +6 volts with respect to cathode, case temperature = 125° C.	I_{GT}	-	-	25	ma
Holding Current at case temperature = 125° C, gate open.	I_{HOO}	-	5	-	ma
Thermal Resistance:					
Junction-to-case.	θ_{JC}	-	-	2°	°C/watt



- a Measured at center of any of the six major surfaces on the perimeter of the hexagonal flange.
- c Between junction and any of the six major surfaces on the perimeter of the hexagonal flange.

OPERATING CONSIDERATIONS

Because this rectifier may operate at voltages which are dangerous, care should be taken in the design of equipment to prevent the operator from coming in contact with the rectifier.

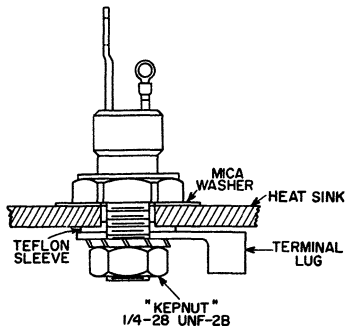
The recommended installation torque is 26 to 36 inch-pounds applied to a 1/4-28 UNF-2B hex nut assembled on stud thread.

The applied torque during installation should not exceed 50 inch-pounds.

SUGGESTED MOUNTING ARRANGEMENT

Device Insulated from Heat Sink

Components shown for mounting (except heat sink) are furnished with each device

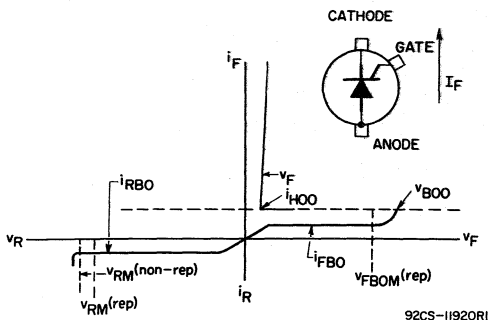


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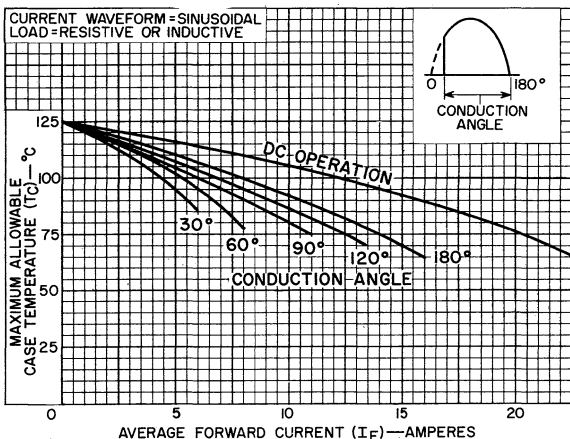


2N681

TYPICAL VOLTAGE AND CURRENT CHARACTERISTIC OF SILICON CONTROLLED-RECTIFIER

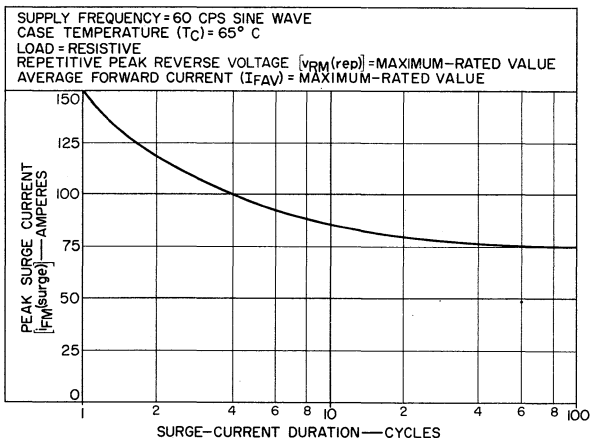


AVERAGE-FORWARD-CURRENT RATING CHART



92CS-11928R2

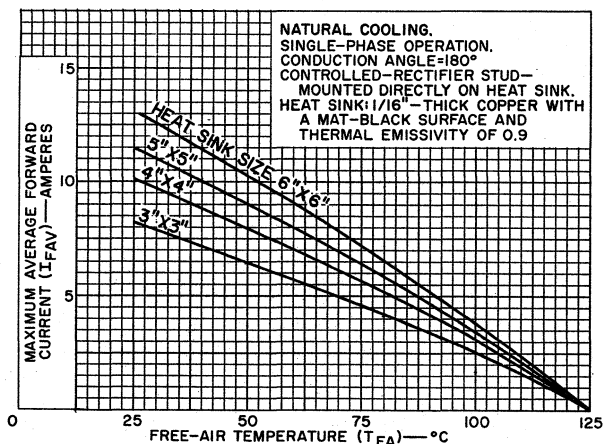
PEAK-SURGE-CURRENT RATING CHART



92CS-11918R1

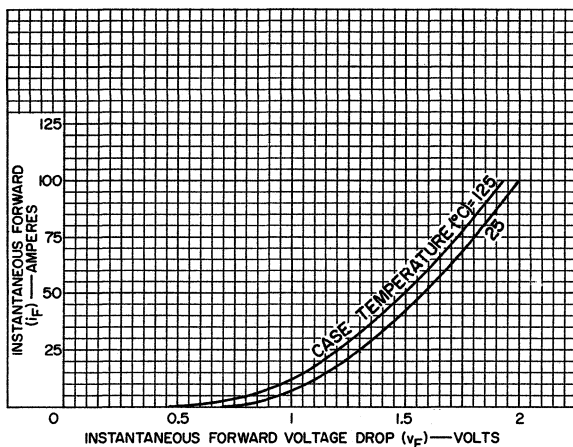


OPERATION GUIDANCE CHART



92CS-11916R1

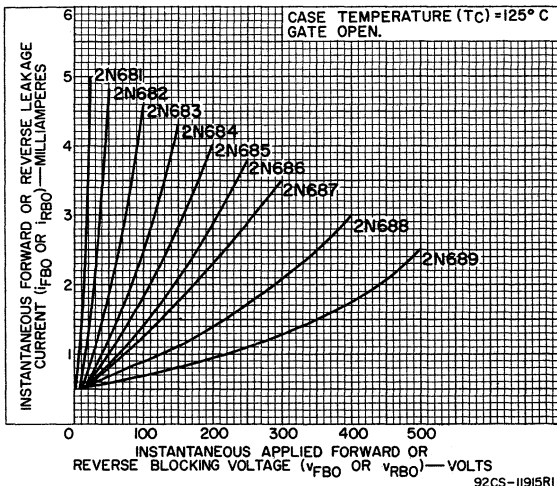
MAXIMUM FORWARD CHARACTERISTICS



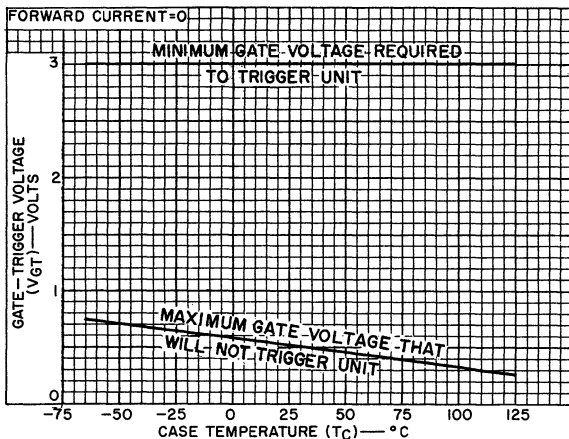
92CS-11917



TYPICAL FORWARD AND REVERSE LEAKAGE-CURRENT CHARACTERISTICS

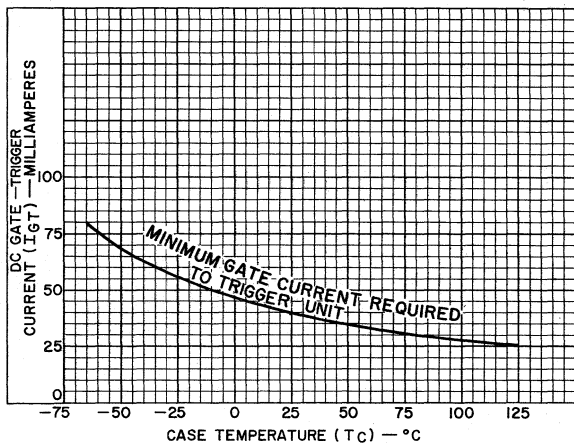


GATE TRIGGER-VOLTAGE CHARACTERISTICS



2N681

DC GATE-TRIGGER-CURRENT CHARACTERISTIC



92CS-11922R2



Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N682 is the same as the 2N681 except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive. $V_{RM}(rep)$ 50 max. volts

Non-repetitive (Transient)

for duration of 5 milli-

seconds maximum $V_{RM}(surge)$ 75 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM}(rep)$ 50 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

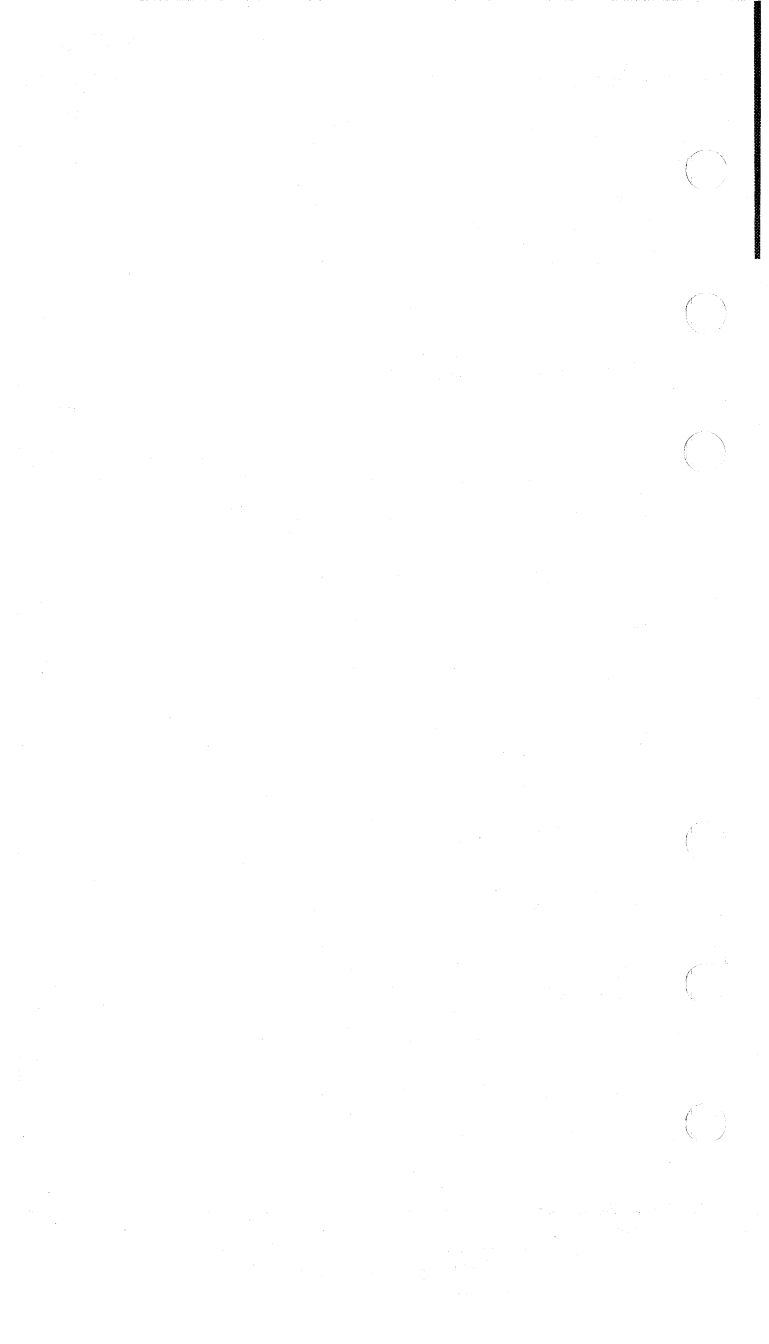
Min. Typ. Max.

Forward Breakover Voltage at

case temperature = 125° C,

gate open V_{BOO} 50 - - volts





Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N683 is the same as the 2N681 except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive. $V_{RM}(rep)$ 100 max. volts

Non-repetitive (Transient)

for duration of 5 milli-

seconds maximum $V_{RM}(surge)$ 150 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM}(rep)$ 100 max. volts

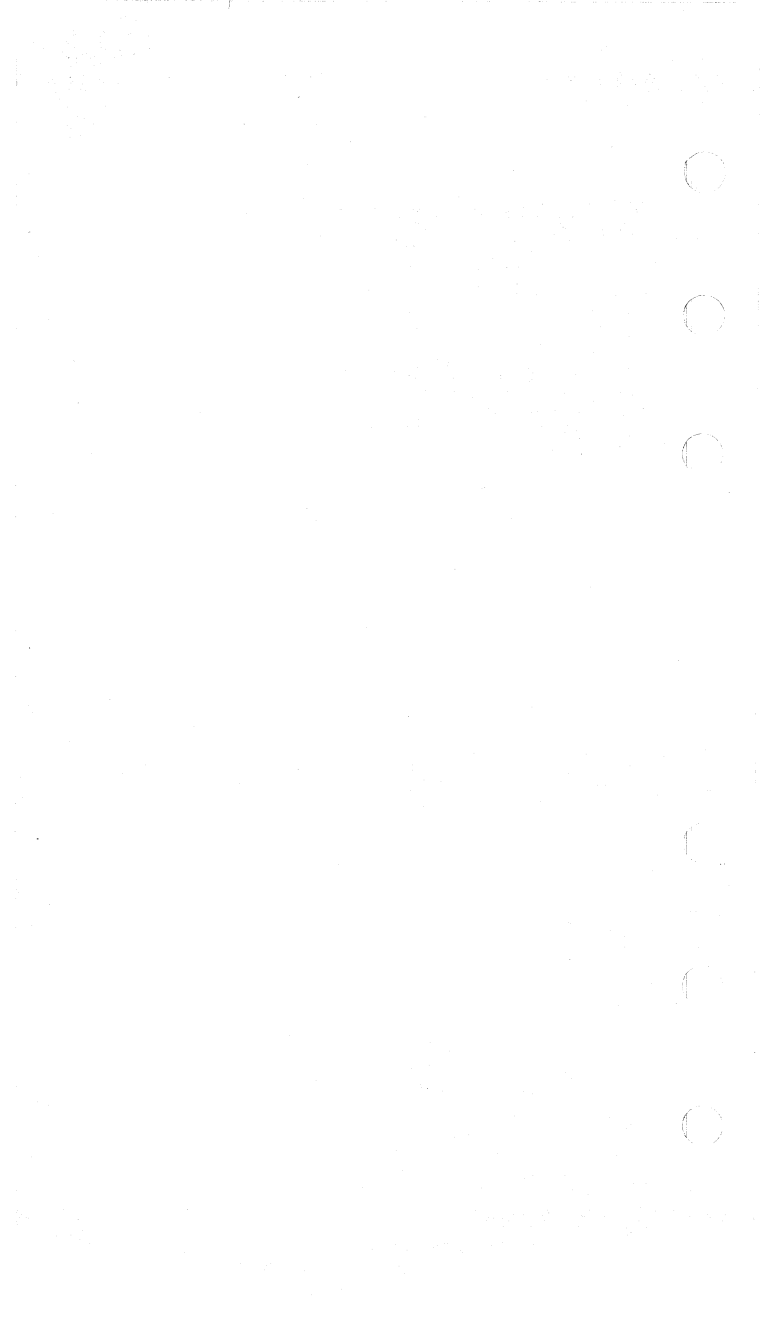
ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at
case temperature = 125° C,

gate open V_{BOO} 100 - - volts





Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N684 is the same as the 2N681 except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate

open):

Repetitive. $V_{RM}(rep)$ 150 max. volts

Non-repetitive (Transient)

for duration of 5 milli-

seconds maximum. $V_{RM}(surge)$ 225 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM}(rep)$ 150 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at

case temperature = 125° C,

gate open. V_{BOO} 150 - - volts



Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N685 is the same as the 2N681 except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive. $V_{RM(rep)}$ 200 max. volts

Non-repetitive (Transient)

for duration of 5 milli-

seconds maximum $V_{RM(surge)}$ 300 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM(rep)}$ 200 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage

at case temperature =

125° C, gate open V_{BOO} 200 - - volts

Average Forward Blocking

Current for one complete

cycle, case temperature

= 125° C, gate open:

Forward I_{FBOAV} - - 6 ma

Reverse I_{RBOAV} - - 6 ma



Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N686 is the same as the 2N681 except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive. $V_{RM}(rep)$ 250 max. volts

Non-repetitive (Transient)

for duration of 5 milli-

seconds maximum. $V_{RM}(surge)$ 350 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM}(rep)$ 250 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at

case temperature = 125° C,

gate open. V_{BOO} 250 - - volts

Average Forward Blocking

Current for one complete

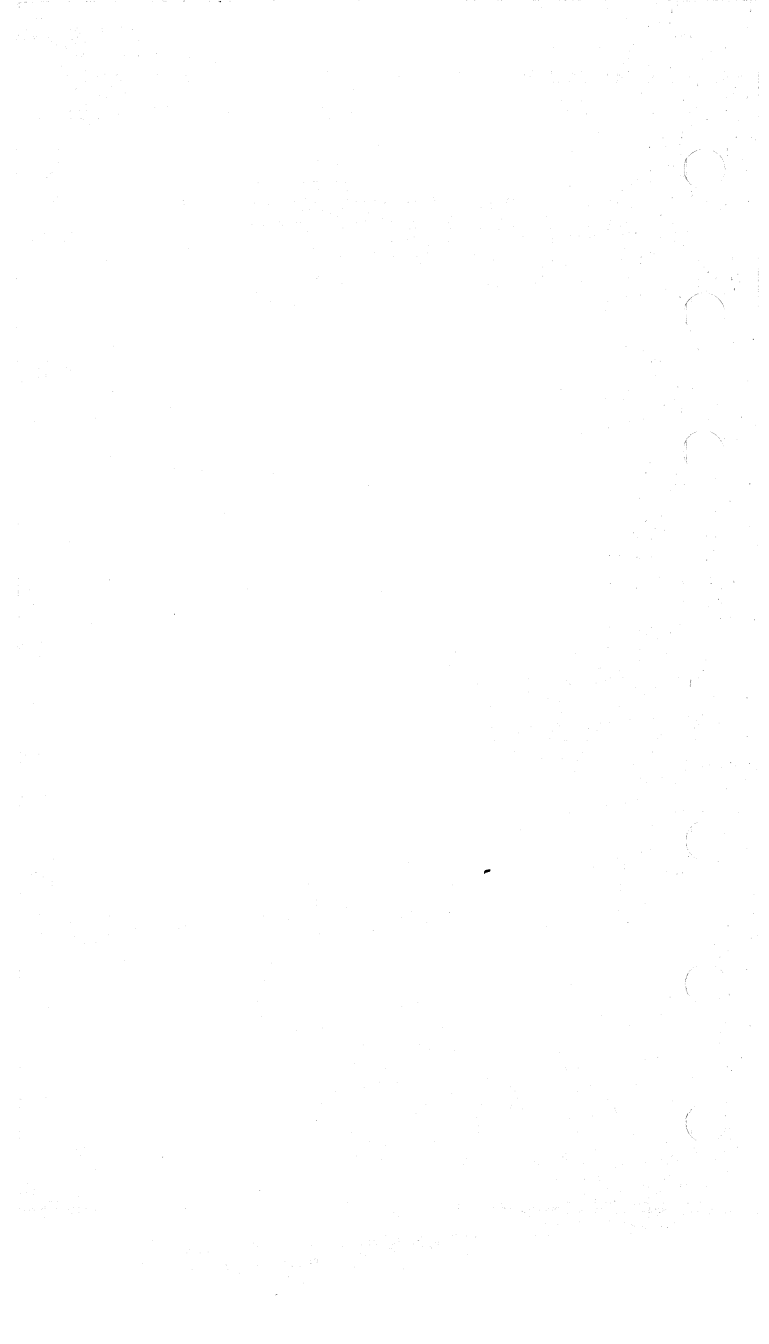
cycle, case temperature

= 125° C, gate open:

Forward. I_{FBOAV} - - 5.5 ma

Reverse. I_{RBOAV} - - 5.5 ma





Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N687 is the same as the 2N681 except for the following items.

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):				
Repetitive.	$V_{RM(rep)}$	300 max.	volts	
Non-repetitive (Transient) for duration of 5 milliseconds maximum	$V_{RM(surge)}$	400 max.	volts	
PEAK FORWARD BLOCKING VOLTAGE (Repetitive):				
With gate open.	$V_{FBOM(rep)}$	300 max.	volts	

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at case temperature = 125° C, gate open				
	V_{BOO}	300	-	- volts
Average Forward Blocking Current for one complete cycle, case temperature = 125° C, gate open:				
Forward	I_{FBOAV}	-	-	5 ma
Reverse	I_{RBOAV}	-	-	5 ma



Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N688 is the same as the 2N681 except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive $V_{RM(rep)}$ 400 max. volts

Non-repetitive (Transient) for duration of 5 milliseconds

maximum $V_{RM(surge)}$ 500 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open $V_{FBOM(rep)}$ 400 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at

case temperature = 125° C,

gate open V_{B00} 400 - - volts

Average Forward Blocking

Current for one complete

cycle, case temperature

= 125° C, gate open:

Forward I_{FBOAV} - - 4 ma

Reverse I_{RBOAV} - - 4 ma



Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N689 is the same as the 2N681 except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive. $V_{RM}^{(rep)}$ 500 max. volts

Non-repetitive (Transient) for duration of 5 milliseconds

maximum. $V_{RM}^{(surge)}$ 600 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM}^{(rep)}$ 500 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at case temperature = 125° C,

gate open. V_{BOO} 500 — — volts

Average Forward Blocking Current for one complete cycle, case temperature = 125° C, gate open:

Forward. I_{FBOAV} — — 3 ma

Reverse. I_{RBOAV} — — 3 ma



Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N690 is the same as the 2N681 except for the following items:

Maximum Ratings, Absolute-Maximum Values:

Unless otherwise specified, for sinusoidal ac supply voltage at a frequency between 50 and 400 cps, with resistive or inductive load

Peak Reverse Voltage

With gate open:

Repetitive. $v_{RM(rep)}$ 600 volts

Non-repetitive (Transient)

for duration of 5 milli-

seconds maximum $v_{RM(non-rep)}$ 720 volts

Peak Forward Blocking Voltage . . . $v_{FBOM(rep)}$ 600 volts

With gate open, repetitive. . .

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, at maximum electrical ratings and at indicated case temperatures

	Min.	Typ.	Max.	
Forward Breakover Voltage. . . v_{BOV}	600	-	-	volts
With gate open,				
$T_C = 125^\circ C$				

Average Blocking Current

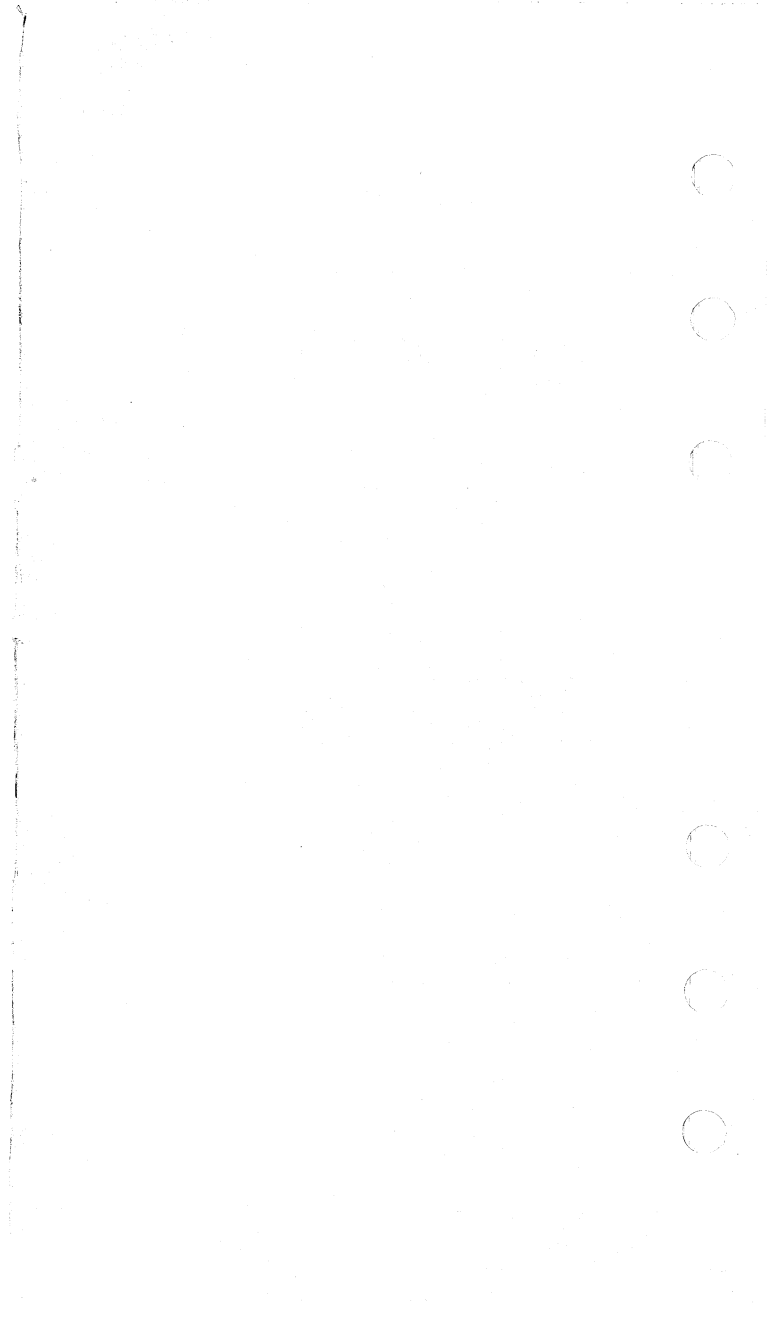
For one complete cycle,

with gate open,

$T_C = 125^\circ C$:

Forward. I_{FBOAV}	-	-	2.5	ma
Reverse. I_{RBOAV}	-	-	2.5	ma





Transistor

SILICON N-P-N DOUBLE-DIFFUSED-JUNCTION TYPE

For Switching Service in Commercial
and Military Data-Processing Systems

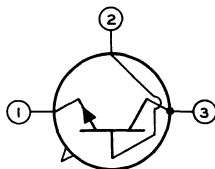
GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-5
Case.	Welded, Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector,
Case

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE with emitter open.	60 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With external base-to-emitter resistor		
(ohms) ≤ 10	40 max.	volts
EMITTER-TO-BASE VOLTAGE with collector open.	5 max.	volts
COLLECTOR CURRENT	500 max.	ma
TRANSISTOR DISSIPATION: ^a		
At case temperature ^b of 25° C or below.	2 max.	watts
At free-air temperature of 25° C or below	0.6 max.	watt
OPERATING TEMPERATURE RANGE:		
Case ^b or free air	-65 to +175	°C
LEAD TEMPERATURE: ^c		
For 10 seconds maximum.	255 max.	°C

^a See accompanying *Rating Chart*.^b Measured at center of seating surface.^c Measured 1/16" $\pm$ 1/32" down from seating surface.

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Somerville, N. J.

DATA 1
8-61

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and free-air temperature of 25° C unless otherwise specified

Min. Typical Max.

DC Collector Breakdown					
Voltage for dc collector ma. = 0.1, emitter open.	BV_{CBO}	60	75	-	volts
DC Collector-to-Emitter					
Voltage for dc collector ma. = 100 ^d , external base-to-emitter resistor (ohms) = 10.	V_{CER}	40	50	-	volts
DC Emitter Breakdown Voltage					
for dc emitter ma. = 0.1, collector open.	BV_{EBO}	5	7.5	-	volts
DC Base-to-Emitter Saturation Voltage for dc collector ma. = 150, dc base ma. = 15.					
	$V_{BE(sat)}$	-	1	1.3	volts
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 150, dc base ma. = 15.					
	$V_{CE(sat)}$	-	0.9	1.5	volts
DC Collector Cutoff Current I_{CBO} for dc collector volts = 30, dc emitter ma. = 0, free-air temperature =					
25° C.		-	0.01	1	μ a
150° C.		-	1	100	μ a
Collector-to-Base Capacitance for dc collector volts = 10, dc emitter ma. = 0.					
	C_{ob}	-	20	35	μ f
DC-Pulse Forward-Current Transfer Ratio for dc collector-to-emitter volts = 10, dc collector ma. = 150, pulse duration (msec) $\leq$ 12, duty factor $\leq$ 0.02. . .					
	h_{FE}	20	40	60	
Small-Signal Forward-Current Transfer Ratio for dc collector-to-emitter volts = 10, dc collector ma. = 50, frequency of 20 Mc. . .					
	h_{fe}	2	4	-	
Gain-Bandwidth Product. . .					
	f_T	-	80	-	Mc

^d Pulsed to prevent excessive heating of collector junction.

^e Frequency at which small-signal forward current transfer ratio is equal to 1.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

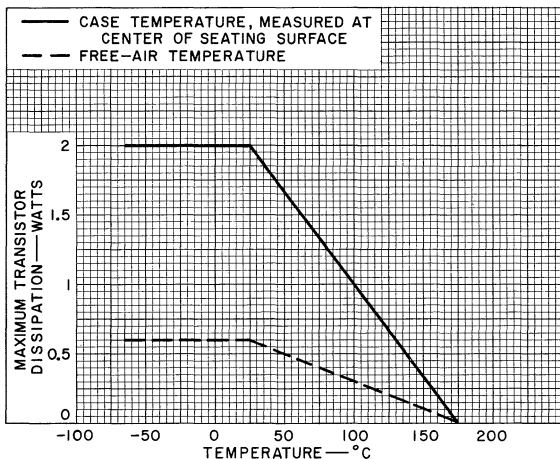


The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

This transistor is intended for use in socketed, single-side printed-circuit boards and in conventional wire-in-type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the boards, and to prevent the collector from shorting to ground.

RATING CHART

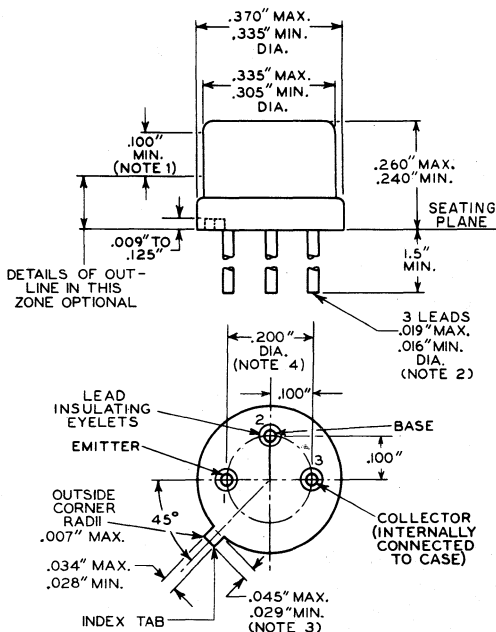


92CS-1116IRI



2N696

JEDEC No. T0-5



92CS-10429R2

NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THE ZONE SHALL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE SEATING PLANE. BETWEEN $0.25''$ AND $1.5''$ A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 3: MEASURED FROM MAXIMUM DIAMETER OF THE ACTUAL DEVICE.

NOTE 4: LEADS HAVING MAXIMUM DIAMETER ($0.019''$) MEASURED IN GAUGING PLANE $0.054'' \pm 0.001'' - 0.000''$ BELOW THE SEATING PLANE OF THE DEVICE SHALL BE WITHIN $0.007''$ OF THEIR TRUE LOCATIONS RELATIVE TO A MAXIMUM-WIDTH TAB.

Transistor

SILICON N-P-N DOUBLE-DIFFUSED-JUNCTION TYPE

For Switching Service in Commercial
and Military Data-Processing Systems

The 2N697 is the same as the 2N696 except for the following items:

ELECTRICAL CHARACTERISTICS

Min. Typical Max.

DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 150, dc base ma. = 15. . . . $V_{CE(sat)}$	-	0.8	1.5	volts
DC-Pulse Forward-Current Transfer Ratio for dc collector-to-emitter volts = 10, dc collector ma. = 150, pulse duration (msec) ≤ 12 , duty factor ≤ 0.02 h_{FE}	40	75	120	
Small-Signal Forward Current Transfer Ratio for dc collector-to- emitter volts = 10, dc collector ma. = 150, frequency of 20 Mc. . . . h_{fe}	2.5	5	-	
Gain Bandwidth Product ^e . . . f_T	-	100	-	Mc

^e Frequency at which small-signal forward current transfer ratio is equal to 1.



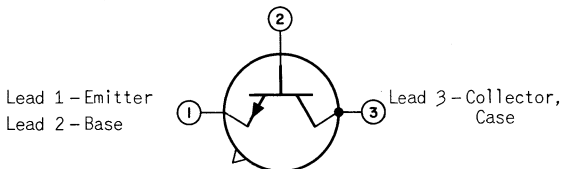
Transistor

SILICON N-P-N TRIPLE-DIFFUSED-JUNCTION PLANAR TYPE
For Industrial and Military Applications

GENERAL DATA

Mechanical:

Dimensions. See Outline T0-5 in General Section
Terminal Diagram: BOTTOM VIEW



INDUSTRIAL SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CBO}	120 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With external resistance (ohms) $\leq$			
10 between base and emitter . . .	V_{CER}	80 max.	volts
EMITTER-TO-BASE VOLTAGE:			
With collector open	V_{EBO}	5 max.	volts
TRANSISTOR DISSIPATION: ^a			
At case temperature ^b of	P		
25° C or below		2 max.	watts
At free-air temperature			
of 25° C or below		0.6 max.	watt
TEMPERATURE RANGE:			
Storage	T_{stg}	-65 to +300	°C
Operating (Junction).	T_J	175 max.	°C

^a See accompanying Rating Chart.

^b Measured at center of seating plane.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless otherwise specified. Case temperature^b of 25° C.

Min. Max.

DC Collector Breakdown			
Voltage for dc collector			
ma. = 0.1, dc emitter			
ma. = 0	BV_{CBO}	120	- volts



2N699

DC Collector-to-Emitter Sustaining Voltage for external base-to-emitter resistance (ohms) ≤ 10 , dc collector ma. = 100, pulse duration (μ sec) ≤ 300 , duty factor ≤ 0.02	$V_{CER(sus)}$	80	-	volts
DC Base-to-Emitter Saturation Voltage for dc collector ma. = 150, dc base ma. = 15.	$V_{BE(sat)}$	-	1.3	volts
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 150, dc base ma. = 15	$V_{CE(sat)}$	-	5	volts
DC Collector-Cutoff Current for dc collector volts = 60, dc emitter ma. = 0.	I_{CBO}	-	2	μ a
DC Emitter-Cutoff Current for dc emitter volts = 5, dc collector ma. = 0.	I_{EBO}	-	100	μ a
Input Resistance at frequency of 1 kc: With dc collector-to-emitter volts = 5, dc collector ma. = 1	h_{ib}	20	30	ohms
With dc collector-to-emitter volts = 10, dc collector ma. = 5		-	10	ohms
Output Capacitance for dc collector volts = 10, dc emitter ma. = 0	C_{ob}	-	20	pf
Output Conductance at frequency of 1 kc: With dc collector-to-emitter volts = 5, dc collector ma. = 1.	h_{ob}	0.1	0.5	μ mho
With dc collector-to-emitter volts = 10, dc collector ma. = 5.		-	1	μ mho
Small-Signal Forward Current Transfer Ratio: With dc collector-to-emitter volts = 5, dc collector ma. = 1, frequency (kc) = 1	h_{fe}	35	100	
With dc collector-to-emitter volts = 10, dc collector ma. = 5, frequency (kc) = 1		45	-	
With dc collector-to-emitter volts = 10, dc collector ma. = 50, frequency (Mc) = 20.		2.5	-	



DC-Pulse Forward-Current
Transfer Ratio for dc
collector-to-emitter
volts = 10, dc collector
ma. = 150, pulse du-
ration (μ sec) ≤ 300 ,
duty factor of ≤ 0.02 . .

Voltage-Feedback Ratio at
frequency of 1 kc:

With dc collector-to-
emitter volts = 5, dc
collector ma. = 1. . .

With dc collector-to-
emitter volts = 10, dc
collector ma. = 5. . .

Thermal Resistance:

Junction-to-case θ_{J-C}
Junction-to-free air . . θ_{J-FA}

h_{FE}	40	120	
h_{rb}			
	-	2.5×10^{-4}	
	-	3×10^{-4}	
	-	75	$^{\circ}\text{C}/\text{watt}$
	-	250	$^{\circ}\text{C}/\text{watt}$

^b Measured at center of seating plane.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

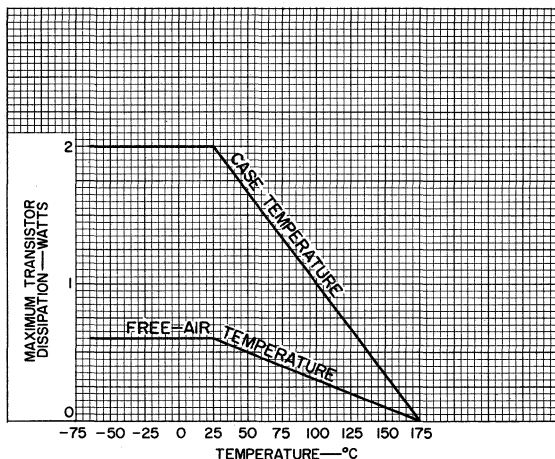
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

This transistor is intended for socketed, single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board, and to prevent the collector from shorting to ground.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

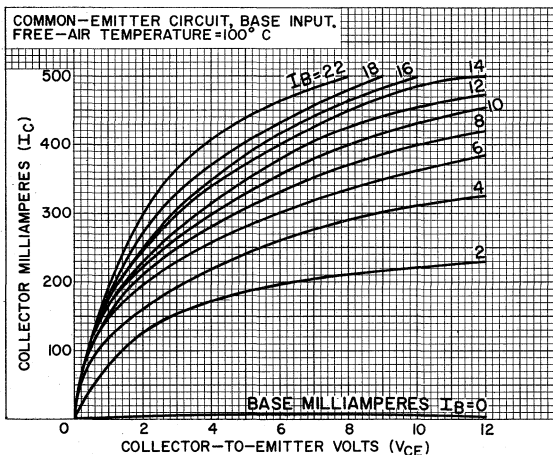


RATING CHART



92CS-11474

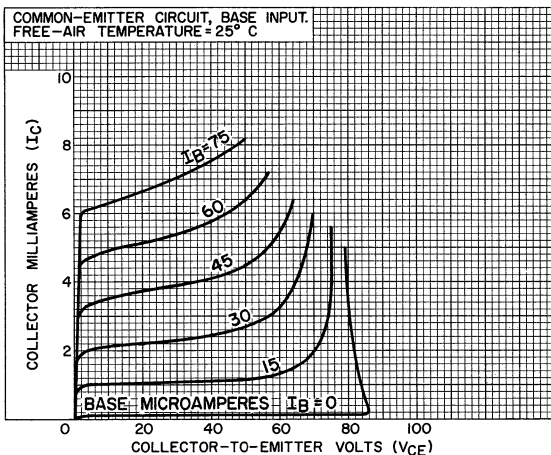
TYPICAL COLLECTOR CHARACTERISTICS



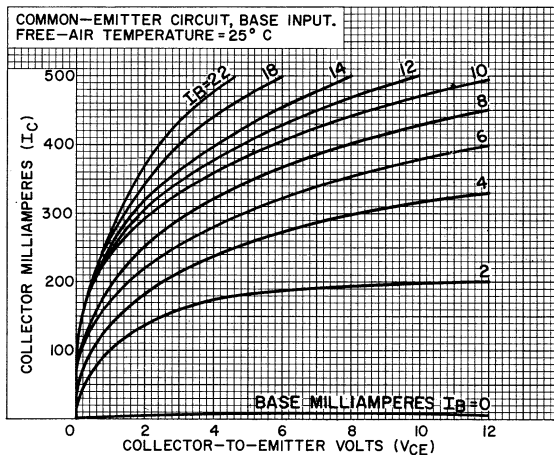
92CS-11180



TYPICAL COLLECTOR CHARACTERISTICS



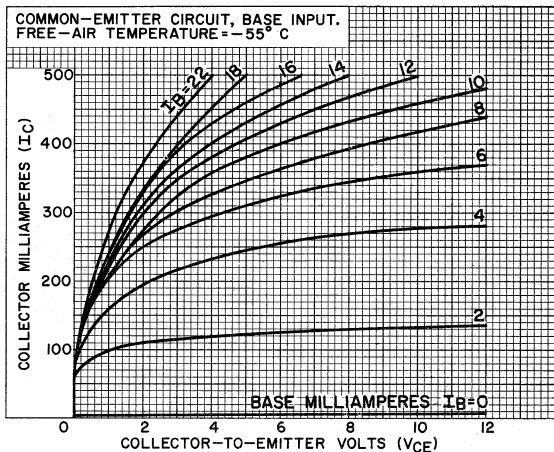
92CS-III75



92CS-III89

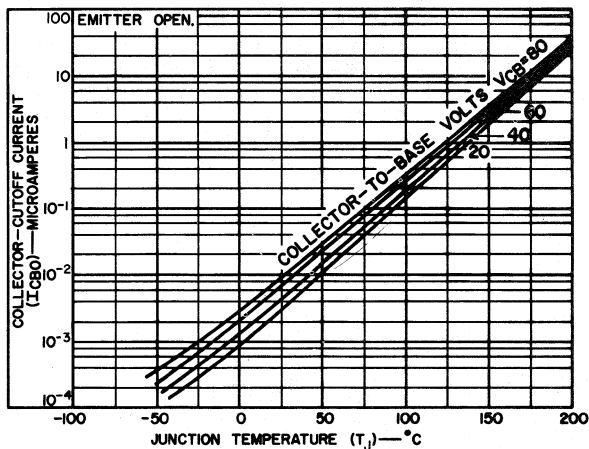


TYPICAL COLLECTOR CHARACTERISTICS



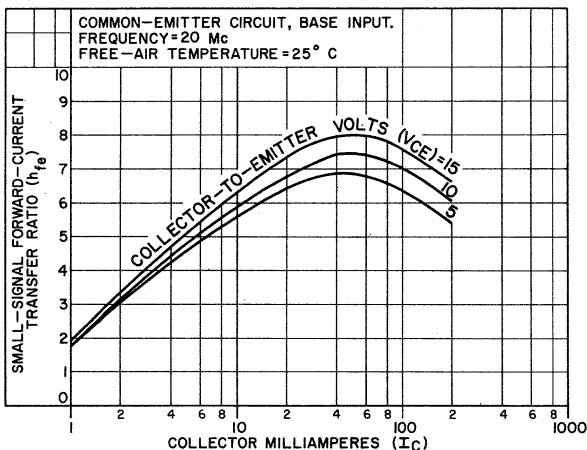
92CS-11191

TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



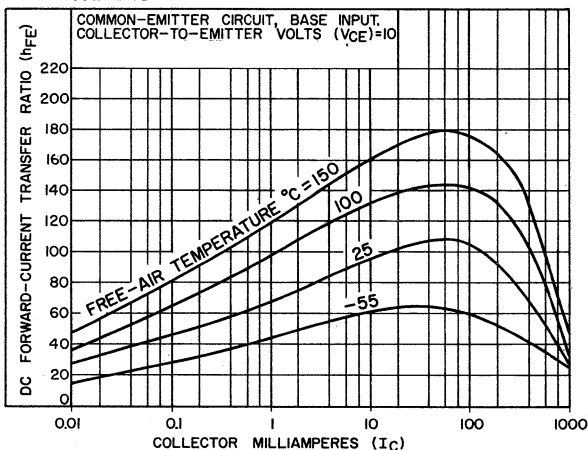
92CS-11480

TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



92CS-11171

TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



92CS-11181R1



Mesa Transistor

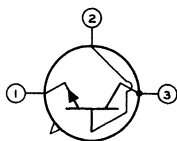
SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Switching Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.210"
Maximum Diameter.	0.230"
Dimensional Outline	JEDEC No. TO-18
Case.	Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	0.500"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

SWITCHING SERVICE

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	25 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE: With external resistor (ohms) = 10 between base and emitter.	20 max.	volts
EMITTER-TO-BASE VOLTAGE	3 max.	volts
TRANSISTOR DISSIPATION (See <i>Rating Chart</i>):		
Operation in free air:		
At ambient temperature of 25° C	0.3 max.	watt
Operation with heat sink:		
At case temperature of 25° C	1 max.	watt
At case temperature of 100° C	0.5 max.	watt
JUNCTION TEMPERATURE.	175 max.	°C

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and ambient temperature of 25° C unless otherwise specified

Min. Typical Max.

DC Base-to-Emitter Saturation Voltage for dc collector ma. = 10, dc base ma. = 1.

V_{BE} (sat)	-	0.75	0.9	volt
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RADIO CORPORATION OF AMERICA
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Somerville, N. J.

DATA 1
2-61

2N706

DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 10, dc base ma. = 1					
	V_{CE}	-	0.3	0.6	volt
DC Collector-Cutoff Current for dc collector volts = 15, emitter open, ambient temperature =					
25° C	I_{CBO}	-	0.005	0.5	μa
150° C		-	3.5	30	μa
Collector-to-Base Capacitance for dc collector volts = 10, emitter open.					
	C_{ob}	-	5	6	μf
DC-Pulse Current Transfer Ratio for dc collector-to-emitter volts = 1, dc collector ma. = 10, pulse duration (msec) ≤ 12 , duty factor ≤ 0.02 .					
	h_{FE}	20	-	-	
Small-Signal Current Transfer Ratio for dc collector-to-emitter volts = 15, dc collector ma. = 10, frequency of 100 Mc.					
	h_{fe}	2	4	-	
Gain-Bandwidth Product . . .	GBW	-	400	-	Mc
Storage Time for dc collector ma. = 10, "turn-on" base ma. (I_{B1}) = 10, "turn-off" base ma. (I_{B2}) = -10					
	t_s	-	16	60	μsec

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.

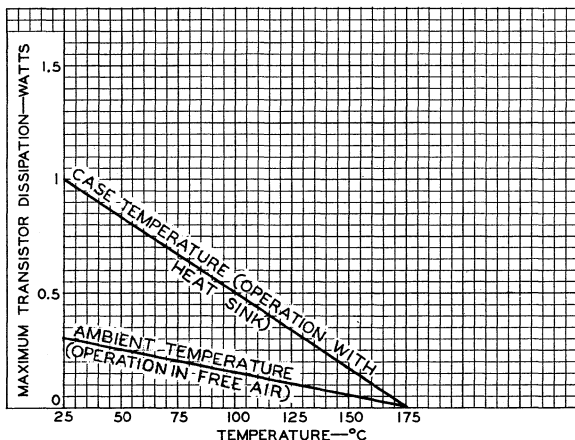
When dip soldering is employed in the assembly of printed circuitry using this transistor, the temperature of the solder should not exceed 255° C for a maximum immersion period of 10 seconds.

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in-type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use as insulating washer or similar standoff device made of good dielectric material to prevent the solder

from shorting the leads to each other or to the board, and to prevent the collector from shorting to ground.

It is to be noted that the case of this transistor operates at the collector voltage. Consideration, therefore, should be given to the possibility of shock hazard, if the case of this transistor is to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

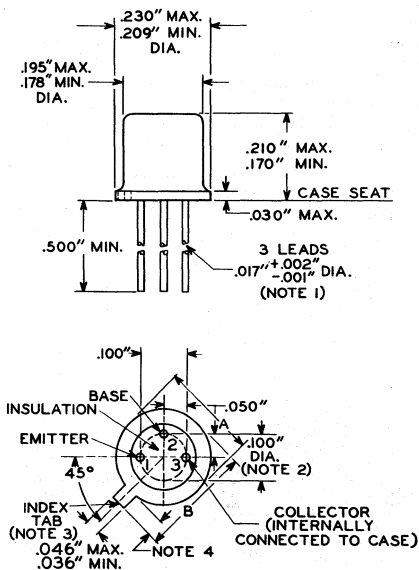
RATING CHART



92CS-10602



2N706



92CS-10605RI

NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ TO THE END OF THE LEAD A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE $0.054'' \pm 0.001'' - 0.000''$ BELOW CASE SEAT TO BE WITHIN $0.007''$ OF THEIR TRUE LOCATION RELATIVE TO MAXIMUM WIDTH TAB AND TO THE MAXIMUM $0.230''$ DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS USED, MEASUREMENT WILL BE MADE AT CASE SEAT.

NOTE 3: FOR VISUAL ORIENTATION ONLY.

NOTE 4: TAB LENGTH TO BE $0.028''$ MINIMUM AND $0.048''$ MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER "A" FROM DIMENSION "B".

Mesa Transistor

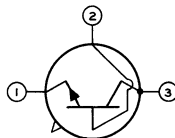
SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Switching Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.210"
Maximum Diameter.	0.230"
Dimensional Outline	JEDEC No. TO-18
Case.	Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	0.500"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter
 Lead 2 - Base



Lead 3 - Collector,
 Case

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	25 max.	volts
COLLECTOR TO EMITTER VOLTAGE:		
With external resistor (ohms) = 10		
between base and emitter.	20 max.	volts
EMITTER-TO-BASE VOLTAGE	5 max.	volts
COLLECTOR DISSIPATION:		
Operation in free air:		
At ambient temperature of 25° C	0.3 max.	watt
Operation with heat sink:		
At case temperature of 100° C	1 max.	watt
JUNCTION TEMPERATURE.	175 max.	°C
AMBIENT-TEMPERATURE RANGE:		
Storage	-65 to +175	°C

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and ambient temperature of 25° C unless otherwise specified

Min. Typical Max.

DC Base-to-Emitter Saturation Voltage for dc collector ma. = 10, dc

base ma. = 1. V_{BE} (sat)	0.7	-	0.9	volt
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RADIO CORPORATION OF AMERICA
 Semiconductor & Materials Division
 Somerville, N. J.

DATA
 2-61

2N706-A

DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 10, dc base ma. = 1.					
	V_{CE}	-	-	0.6	volt
DC Collector-Cutoff Current for dc collector volts = 15, emitter open, ambient temperature =					
25° C	I_{CBO}	-	-	0.5	μa
150° C		-	-	30	μa
DC Current Transfer Ratio for collector-to-emitter volts = 1, dc collector ma. = 10.					
	h_{FE}	20	-	60	
Small-Signal Current Transfer Ratio for dc collector-to-emitter volts = 10, dc collector ma. = 10, frequency of 100 Mc					
	h_{fe}	2	-	-	
"Turn-On" Time for dc collector supply volts = 3, "turn-on" base ma. (I_{B1}) = 3, "turn-off" base ma. (I_{B2}) = -1					
		-	-	40	μsec
"Turn-Off" Time for dc collector supply volts = 3, "turn-on" base ma. (I_{B1}) = 3, "turn-off" base ma. (I_{B2}) = -1					
		-	-	75	μsec
Storage Time for dc collector ma. = 10, "turn-on" base ma. (I_{B1}) = 10, "turn-off" base ma. (I_{B2}) = 10.					
	t_s	-	-	25	μsec

OPERATING CONSIDERATIONS
and DIMENSIONAL OUTLINE
shown under Type 2N706 also apply to the 2N706-A



Transistor

SILICON N-P-N DOUBLE-DIFFUSED-JUNCTION PLANAR TYPE

For Switching and Amplifier Applications
in Industrial and Military Equipment

GENERAL DATA

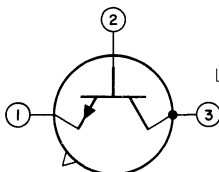
Mechanical:

Dimensions. See Outline T0-18 in General Section

Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector,
Case

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CBO} 40 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With external resistance between
base and emitter (ohms) ≤ 10 . . . V_{CER} 20 max. volts

With base open V_{CEO} 15 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EB0} 5 max. volts

COLLECTOR CURRENT. I_C Limited by power dissipation

TRANSISTOR DISSIPATION:^a

P

At case temperature^b of 25° C

or below 1.2 max. watts

At case temperature^b of 100° C 0.68 max. watt

At free-air temperature of 25° C

or below 0.36 max. watt

TEMPERATURE RANGE:

Storage. T_{stg} -65 to +300 °C

Operating (Junction) T_J 200 max. °C

LEAD TEMPERATURE T_L 300 max. °C

^a See accompanying Rating Chart.

^b Measured at center of seating plane.

← Indicates a change.



ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and free-air temperature of 25° C unless otherwise specified.

		Min.	Max.	
DC Collector Breakdown Voltage for dc collector ma. = 0.001, emitter ma. = 0. . . .	BV _{CBO}	40	—	volts
DC Emitter Breakdown Voltage for dc emitter ma. = 0.1, collector ma. = 0	BV _{EBO}	5	—	volts
DC Collector-to-Emitter Sustaining Voltage: With dc pulse-collector ma. = 30, external base-to-emitter resistance (ohms) ≤ 10.	V _{CER(sus)}	20	—	volts
With dc pulse-collector ma. = 30, base open	V _{CEO(sus)}	15	—	volts
DC Base-to-Emitter Saturation Voltage: With dc collector ma. = 10, dc base ma. = 1, free-air temperature = 25° C	V _{BE(sat)}	0.72	0.8	volt
With dc collector ma. = 7, dc base ma. = 0.7, free-air temperature = -55° C. . . .		—	0.9	volt
DC Collector-to-Emitter Saturation Voltage: With dc collector ma. = 10, dc base ma. = 1, free-air temperature = 25° C	V _{CE(sat)}	—	0.4	volt
With dc collector ma. = 7, dc base ma. = 0.7, free-air temperature range = -55 to +125° C		—	0.4	volt
DC Collector-Cutoff Current for dc collector volts = 20, dc emitter ma. = 0, free-air temperature = 25° C	I _{CB0}	—	0.025	μa
150° C.		—	15	μa
→ DC Collector Current for base-to-emitter forward bias volts = 0.25, dc collector-to-emitter volts = 20, free-air tempera- ture = 125° C	I _{CEX}	—	10	μa
DC Emitter-Cutoff Current for dc base-to-emitter volts = 4, dc collector ma. = 0.	I _{EBO}	—	0.08	μa

→ Indicates a change.

Base-Spreading Resistance^c

for dc collector-to-emitter volts = 10, dc collector ma. = 10, frequency (Mc) = 300

r_b - 50 ohms

Collector-to-Base Capacitance

for dc collector volts = 10, dc emitter ma. = 0

C_{ob} - 6 pf

Small-Signal Forward-Current

Transfer Ratio for dc collector-to-emitter volts = 10, dc collector ma. = 10, frequency (Mc) = 100

h_{fe} 3 -

DC Forward-Current Transfer Ratio:

h_{FE}

With dc collector-to-emitter volts = 1, free-air temperature = 25° C, dc collector ma. =

10 30 120

0.5 15 -

With dc collector-to-emitter

volts = 1, dc collector

ma. = 10, free-air

temperature = -55° C

15 -

Storage Time^d for dc collector

supply volts = 10, collector

resistance (ohms) = 1000,

turn-on dc base ma. = 10,

turn-off dc base ma. = -10,

dc collector ma. = 10. . . .

t_s - 25 nsec

Thermal Resistance:

Junction-to-case

θ_{J-C} - 145 °C/watt

Junction-to-free air

θ_{J-FA} - 480 °C/watt

^c Base-Spreading Resistance (r_b) is the product of R_e and h_{ie} (small-signal value of the short-circuit input impedance).

^d See accompanying *Storage-Time-Measurement Circuit*.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

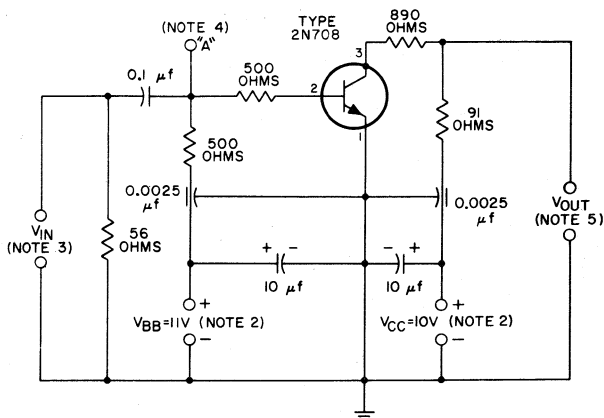
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



2N708

STORAGE-TIME-MEASUREMENT CIRCUIT



92CS-11228RI

NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25- μf DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB} .

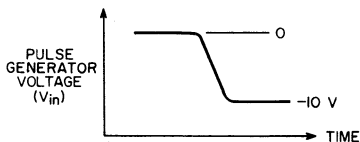
NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS.

NOTE 4: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

NOTE 5: INPUT AND OUTPUT WAVEFORMS SHOWN SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE SIMILAR TO HEWLETT-PACKARD MODEL 185A (OR EQUIVALENT) WITH HIGH-IMPEDANCE PROBE.

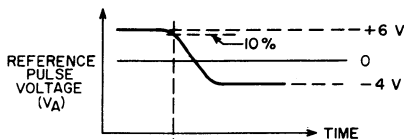


ASSOCIATED WAVE FORMS

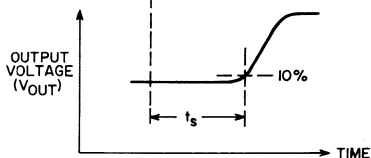


RISE TIME $< 1\text{m}\mu\text{SEC}$
 PULSE DURATION $\geq 300\text{m}\mu\text{SEC}$
 DUTY FACTOR < 0.02

INPUT WAVE FORM



REFERENCE WAVE FORM OBSERVED
 AT POINT "A" IN STORAGE-TIME-
 MEASUREMENT CIRCUIT

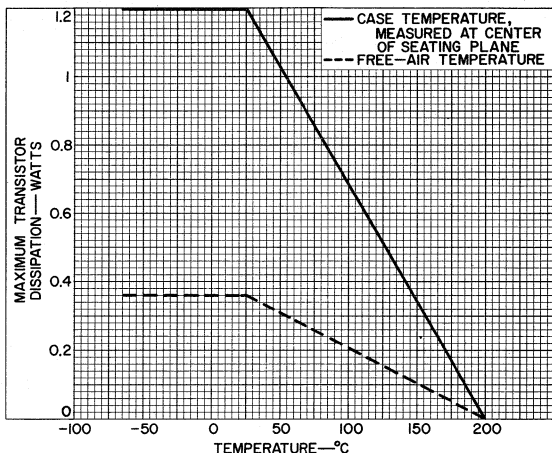


OUTPUT WAVE FORM

92CS-11224



RATING CHART

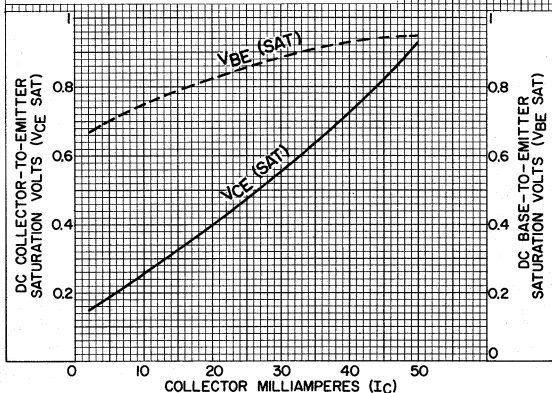


92CS-11231R1

TYPICAL

DC SATURATION-VOLTAGE CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
 COLLECTOR CURRENT (I_C)/BASE CURRENT (I_B)=10
 FREE-AIR TEMPERATURE (T_{FA})=25° C

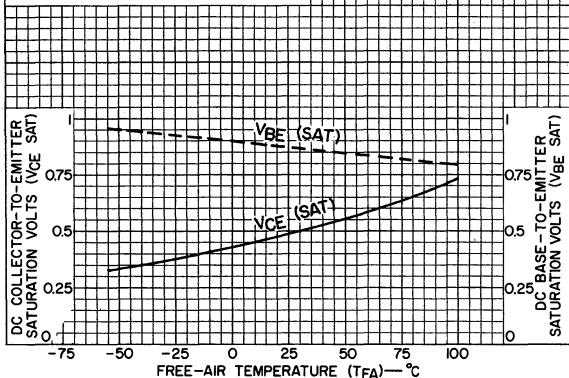


92CS-11525



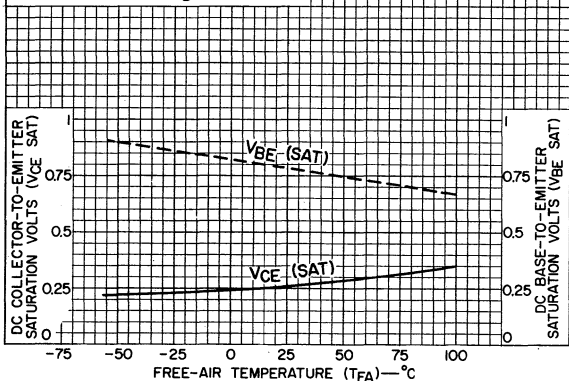
TYPICAL DC SATURATION-VOLTAGE CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
COLLECTOR MILLIAMPERES (I_C)=25
BASE MILLIAMPERES (I_B)=2.5



92CS-11520

COMMON-EMITTER CIRCUIT, BASE INPUT.
COLLECTOR MILLIAMPERES (I_C)=10
BASE MILLIAMPERES (I_B)=1



92CS-11522

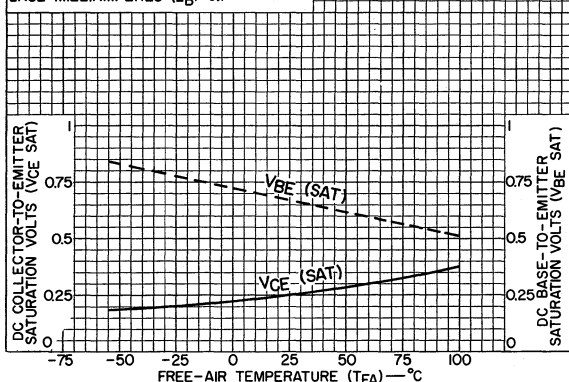


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DATA 4
4-62

TYPICAL DC SATURATION-VOLTAGE CHARACTERISTICS

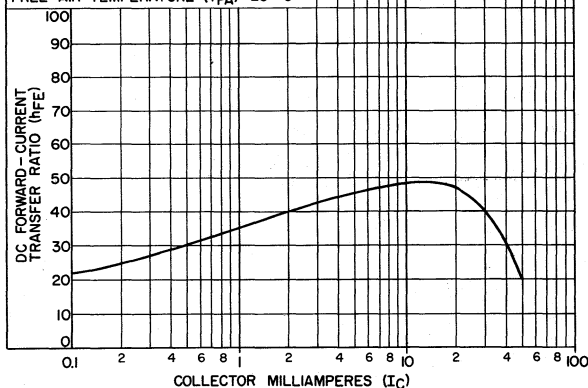
COMMON-EMITTER CIRCUIT, BASE INPUT.
COLLECTOR MILLIAMPERES (I_C)=1
BASE MILLIAMPERES (I_B)=0.1



92CS-11521

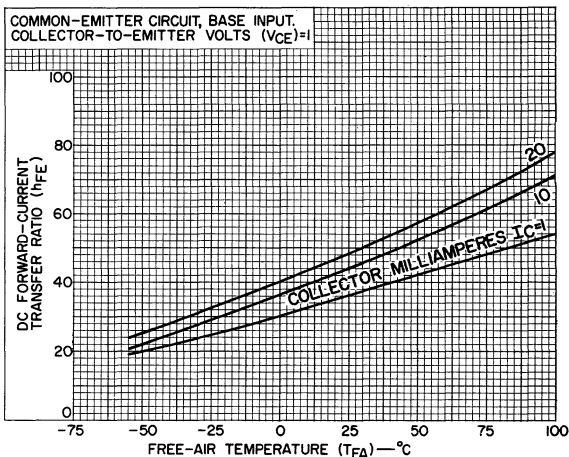
TYPICAL DC FORWARD-CURRENT-TRANSFER-RATIO CHARACTERISTIC

COMMON-EMITTER CIRCUIT, BASE INPUT.
COLLECTOR-TO-EMITTER VOLTS (V_{CE})=1
FREE-AIR TEMPERATURE (T_{FA})=25° C



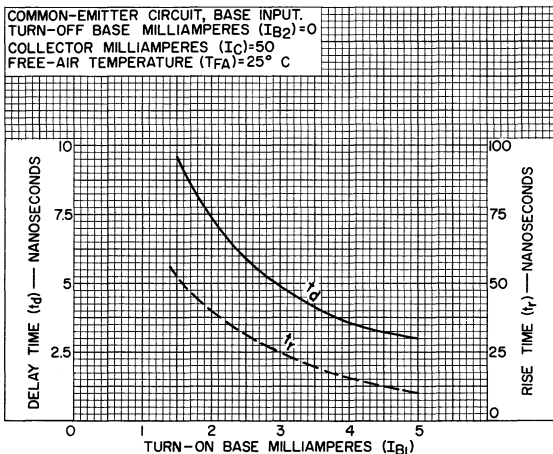
92CS-11527

TYPICAL DC FORWARD-CURRENT-TRANSFER-RATIO CHARACTERISTICS



92CS-11524

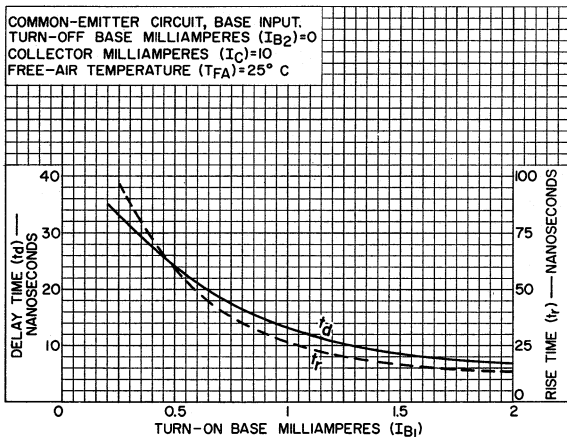
TYPICAL DELAY-TIME AND RISE-TIME CHARACTERISTICS



92CS-11505

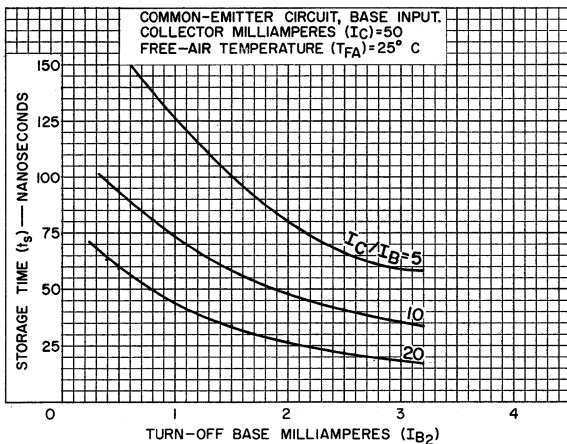


TYPICAL DELAY-TIME AND RISE-TIME CHARACTERISTICS



92CS-11503

TYPICAL STORAGE-TIME CHARACTERISTICS

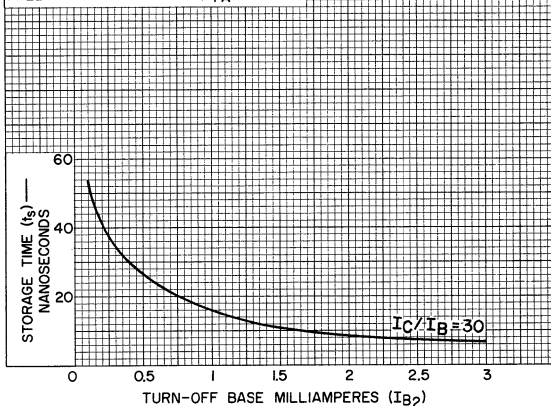


92CS-11507



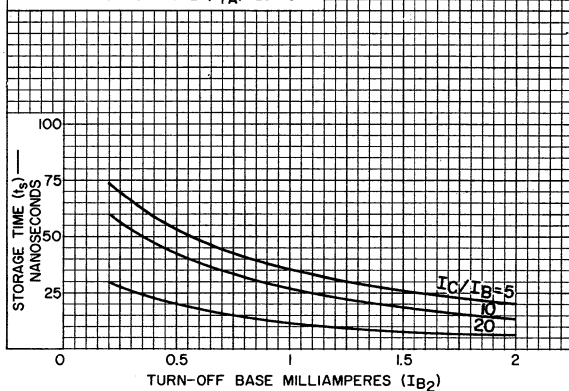
TYPICAL STORAGE-TIME CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
COLLECTOR MILLIAMPERES (I_C)=20
FREE-AIR TEMPERATURE (T_{FA})=25° C



92CS-11504

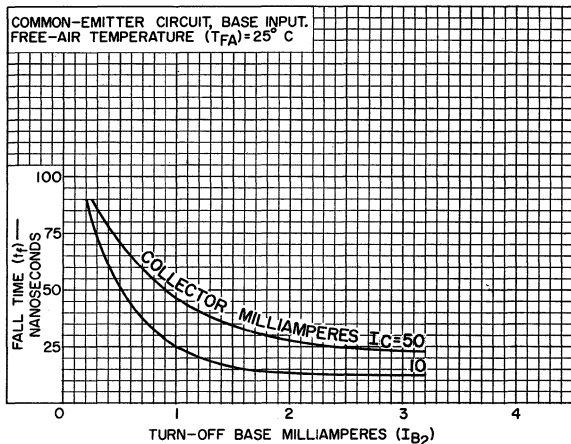
COMMON-EMITTER CIRCUIT, BASE INPUT.
COLLECTOR MILLIAMPERES (I_C)=10
FREE-AIR TEMPERATURE (T_{FA})=25° C



92CS-11508



TYPICAL FALL-TIME CHARACTERISTICS



92CS-11580

Transistor

SILICON N-P-N EPITAXIAL-PLANAR TYPE

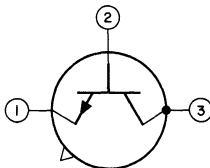
For Ultra-High-Speed Logic-Circuit Switching Applications
in Commercial and Military Data-Processing Systems.
The 2N2475 is a Direct Replacement for Type 2N709.

GENERAL DATA

Mechanical:

Dimensions. See *Outline T0-18* in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1—Emitter
Lead 2—Base



Lead 3—Collector,
Case

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CBO}	15 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open.	V_{CEO}	6 max.	volts
EMITTER-TO-BASE VOLTAGE:			
With collector open	V_{EBO}	4 max.	volts
COLLECTOR CURRENT	I_C	Limited by power dissipation	
TRANSISTOR DISSIPATION: ^a			
At case temperature ^b of	P		
100° C or below		500 max.	mw
At free-air temperature of			
25° C or below.		300 max.	mw
TEMPERATURE RANGE:			
Junction (Operating).	T_J	-65 to +200	°C
Storage	T_{STG}	-65 to +300	°C
LEAD TEMPERATURE: ^c			
For 10 seconds maximum.	T_L	300 max.	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, free-air temperature = 25° C
Min. Typical Max.

DC Collector Breakdown Voltage			
for dc collector ma. = 0.01,			
dc emitter current = 0 . . . BV_{CBO}			
	15	30	— volts

^a See accompanying *Rating Chart*.

^b Measured at center of seating plane.

^c Measured 1/16" ± 1/32" along lead, down from seating plane.



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DATA 1
8-62

2N709

Min. Typical Max.

DC Emitter Breakdown

Voltage for dc collector

current = 0, dc emitter

ma. = 0.01 BV_{EBO} 4 7 - volts

DC Collector-to-Emitter

Sustaining Voltage^d

for dc pulsed collector

ma. = 10, dc base cur-

rent = 0 $V_{CEO(sus)}$ 6 10 - volts

DC Base-to-Emitter Satu-

ration Voltage for dc

collector ma. = 3, dc

base ma. = 0.15 $V_{BE(sat)}$ 0.7 0.77 0.85 volt

DC Collector-to-Emitter

Saturation Voltage for

dc collector ma. = 3, dc

base ma. = 0.15 $V_{CE(sat)}$ - 0.26 0.3 volt

DC Collector-Cutoff

Current for dc col-

lector-to-base volts

= 5, dc emitter current

= 0, free-air tempera-

ture =

25° C. - 0.002 0.05 μ a

150° C. - 0.9 5 μ a

Emitter-to-Base Capaci-

tance for dc emitter-to-

base volts = -0.5, dc

collector current = 0,

frequency (kc) = 140

(Approx.) C_{ib} - 1.8 2 pf

Collector-to-Base Capaci-

tance for dc collector-

to-base volts = 5, dc

emitter current = 0,

frequency (kc) = 140

(Approx.) C_{ob} - 2.1 3 pf

DC Forward-Current

Transfer Ratio:

With dc collector-to-

emitter volts = 1,

dc pulsed collector

ma. = 30 15 43 -

With dc collector-to-

emitter volts = 0.5,

dc pulsed collector

ma. = 10 20 53 120

With dc collector-to-

emitter volts = 0.5,

dc pulsed collector

ma. = 10, free-air

temperature = -55° C. 10 29 -



Small-Signal Short-Circuit
Forward-Current Transfer
Ratio for dc collector-
to-emitter volts = 4,
dc collector ma. = 5,
signal frequency (Mc)
= 100.

h_{fe} 6 8 -

Switching Time:

Storage time^e for dc
collector ma. = 5,
turn-on dc base ma.
= 5, turn-off dc base
ma. = -5

t_s - 4.1 6 nsec

Turn-On time^f (Delay
time + rise time) for
dc collector ma. = 10,
turn-on dc base ma.
= 2, turn-off dc base
ma. = -1

t_{on} - 6.4 15 nsec

Turn-Off time^f (Storage
time + fall time) for
dc collector ma. = 10,
turn-on dc base ma.
= 1, turn-off dc base
ma. = -1

t_{off} - 8.3 15 nsec

^d The Collector-to-Emitter Sustaining Voltage [$V_{CE0(sus)}$] with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^e See accompanying *Storage-Time-Measurement Circuit*.

^f See accompanying *Turn-On-Time and Turn-Off-Time Measurement Circuit*.

OPERATING CONSIDERATIONS,
RATING CHART,
STORAGE-TIME MEASUREMENT CIRCUIT,
TURN-ON-TIME AND TURN-OFF-TIME MEASUREMENT CIRCUIT,
and ASSOCIATED WAVE FORMS
shown under type 2N2475 also apply to the 2N709



Transistor

SILICON N-P-N TRIPLE-DIFFUSED-JUNCTION PLANAR TYPE

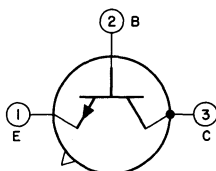
For Small-Signal and Switching Applications in Industrial and Military Equipment

GENERAL DATA

Mechanical:

Dimensions See Outline T0-18 in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

INDUSTRIAL SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CBO} 75 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With external resistance between

base and emitter (ohms) ≤ 10 V_{CER} 50 max. volts

With base open V_{CEO} 32 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EB0} 7 max. volts

TRANSISTOR DISSIPATION:

At case temperatures:^a

From -65° to 25° C 1.8 max. watts

Above 25° C Derate linearly 0.0102 watt/ $^{\circ}$ C

At free-air temperatures:

From -65° to 25° C 0.5 max. watt

Above 25° C Derate linearly 0.0028 watt/ $^{\circ}$ C

TEMPERATURE:

Operating range (Junction) T_{opr} -65 to 200 $^{\circ}$ C

Storage range. T_{stg} -65 to 300 $^{\circ}$ C

Lead:^b

For 10 seconds maximum T_L 255 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, free-air temperature = 25° C

Min. Max.

DC Collector-to-Base Breakdown

Voltage for dc collector ma.

= 0.1, emitter current = 0 BV_{CBO} 75 - volts



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Electronic Components and Devices
Harrison, N. J.

DATA 1
9-63

Min. Max.

DC Emitter-to-Base Breakdown Voltage for dc emitter ma. = 0.1, collector current = 0.	BV_{EBO}	7	-	volts
DC Collector-to-Emitter Sustaining Voltage for external resistance between base and emitter (ohms) = 10, pulsed-dc collector ma. ^c = 100	$V_{CER(sus)}$	50	-	volts
DC Collector-to-Emitter Saturation Voltage for pulsed-dc collector ma. ^c = 150, pulsed-dc base ma. ^c = 15	$V_{CE(sat)}$	-	1.5	volts
DC Base-to-Emitter Saturation Voltage for pulsed-dc collector ma. ^c = 150, pulsed dc base ma. ^c = 15	$V_{BE(sat)}$	-	1.3	volts
DC Collector-Cutoff Current for dc collector-to-base volts = 60, emitter current = 0, free-air temperature (°C) = 25	I_{CBO}	-	0.01	μa
150.	I_{CBO}	-	10	μa
DC Emitter-Cutoff Current for dc emitter-to-base volts = 5, collector current = 0	I_{EBO}	-	0.01	μa
Input Impedance at frequency (kc) = 1: With dc collector-to-base volts = 5, dc collector ma. = 1.	h_{ib}	24	34	ohms
With dc collector-to-base volts = 10, dc collector ma. = 5.	h_{ib}	4	8	ohms
Input Capacitance for dc emitter-to-base volts = 0.5, collector current = 0.	C_{ib}	-	80	pf
Output Capacitance for dc collector-to-base volts = 10, emitter current = 0.	C_{ob}	-	25	pf
Output Conductance at frequency (kc) = 1: With dc collector-to-base volts = 5, dc collector ma. = 1.	h_{ob}	0.1	0.5	μmho
With dc collector-to-base volts = 10, dc collector ma. = 5.	h_{ob}	0.1	1	μmho



Min. Max.

DC Forward-Current Transfer
Ratio for dc collector-
to-emitter volts = 10,
dc collector ma. =

0.1	h_{FE}	20	-
10 (Pulsed) ^c	h_{FE}	35	-
150 (Pulsed) ^c	h_{FE}	40	120
500 (Pulsed) ^c	h_{FE}	20	-
10 (Pulsed), ^c free-air-tem- perature (°C) = -55	h_{FE}	20	-

Small-Signal Short-Circuit
Forward-Current Transfer
Ratio:

With dc collector-to-
emitter volts = 5, dc
collector ma. = 1, fre-
quency (kc) = 1 h_{fe} 30 100

With dc collector-to-emitter
volts = 10, dc col-
lector ma. = 5, fre-
quency (kc) = 1 h_{fe} 35 150

With dc collector-to-
emitter volts = 10, dc
collector ma. = 50, fre-
quency (Mc) = 20 h_{fe} 3 -

Small-Signal Open-Circuit
Reverse Voltage Trans-
fer (Feedback) Ratio at
frequency (kc) = 1:

With dc collector-to-
base volts = 5, dc
collector ma. = 1 h_{rb} - 0.0003

With dc collector-to-
base volts = 10, dc
collector ma. = 5 h_{rb} - 0.0003

Noise Figure for circuit
bandwidth (cps) = 1, fre-
quency (kc) = 1, generator
resistance (ohms) = 510,
dc collector-to-emitter
volts = 10, dc collector
ma. = 0.3 NF - 12 db

Total Switching Time^d (Delay
time + rise time + fall
time) t_{tsw} - 30 nsec.

Thermal Resistance:

Junction-to-case	θ_{JC}	-	97 °C/watt
Junction-to-free-air	θ_{JFA}	-	350 °C/watt

^a Measured at center of seating plane.

^b Measured along lead at distance not less than 1/32" from seating plane.

^c Pulse duration $\leq 300 \mu\text{sec}$, duty factor ≤ 0.02 .

^d See accompanying *Total-Switching-Time-Measurement Circuit*.



2N718A

OPERATING CONSIDERATIONS

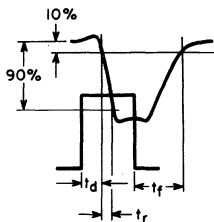
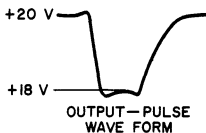
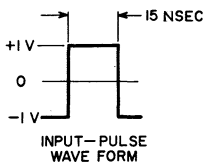
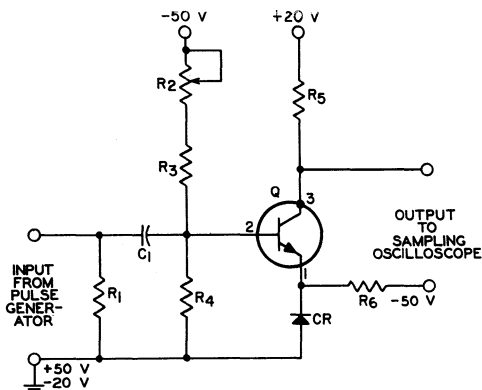
This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The leads of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



TOTAL-SWITCHING-TIME MEASUREMENT CIRCUIT AND ASSOCIATED WAVE FORMS



92CS-11186R2

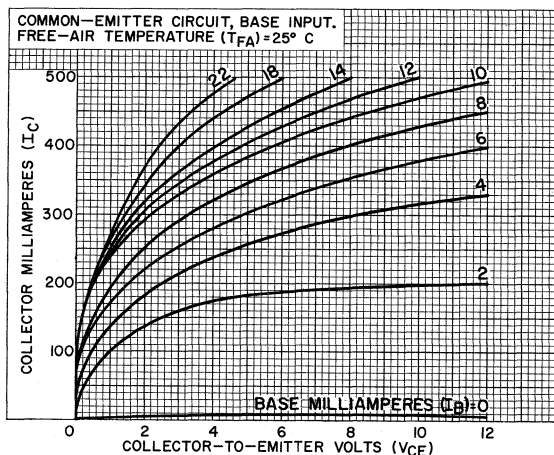
C_1 : 0.01 μ f
 CR: Semiconductor diode
 type FD100
 Q: Transistor type 2N718A
 R_1 : 100 ohms

R_2 : 1000 ohms
 R_3 : 4700 ohms
 R_4 : 100 ohms
 R_5 : 40 ohms
 R_6 : 1000 ohms, 5 watts

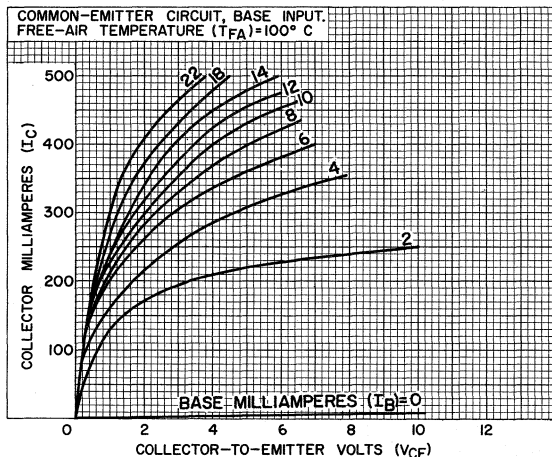


2N718A

TYPICAL COLLECTOR CHARACTERISTICS



92CS-11189

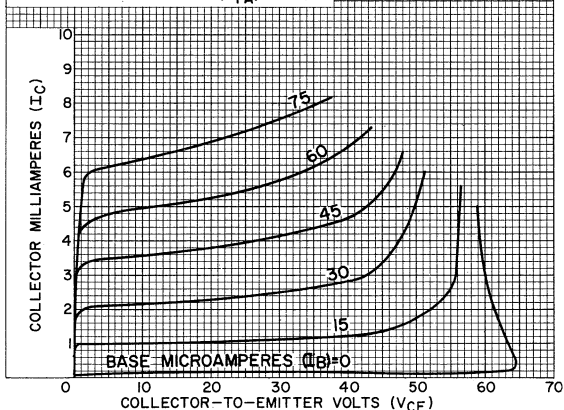


92CS-11177



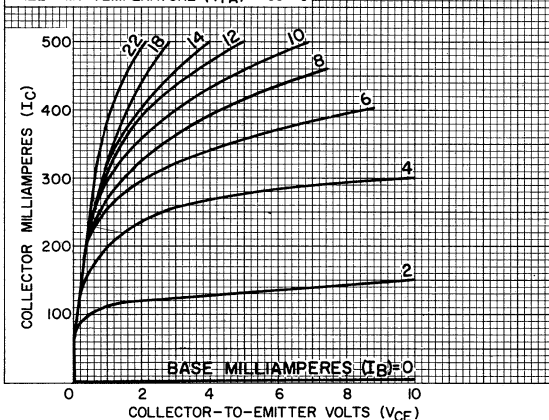
TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE (T_{FA}) = 25° C



92CS-III78

COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE (T_{FA}) = -55° C

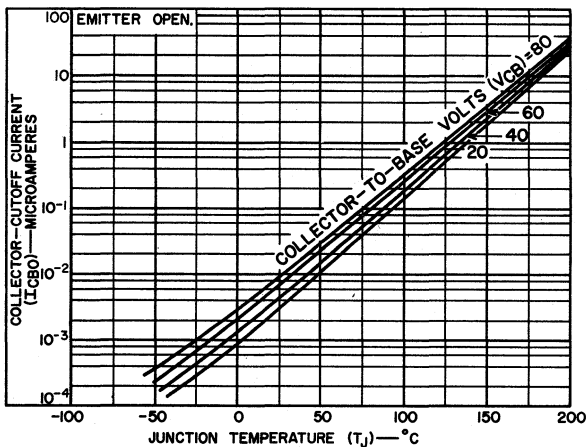


92CS-III90



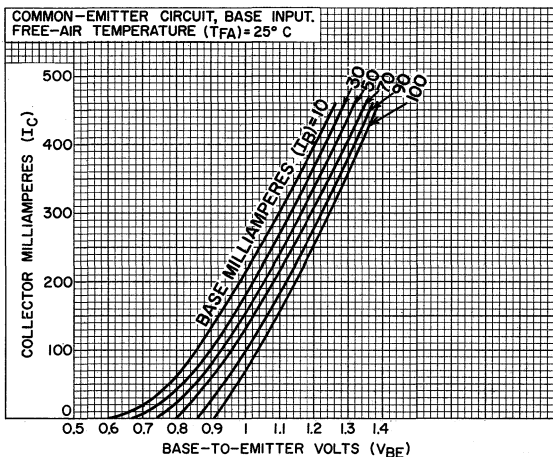
2N718A

TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



92CS-11480

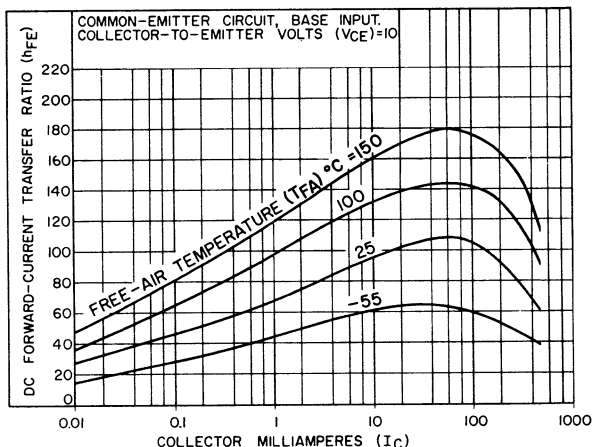
TYPICAL TRANSFER CHARACTERISTICS



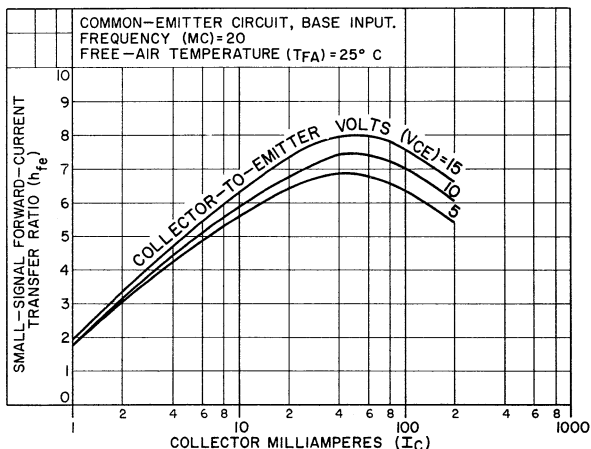
92CS-11185



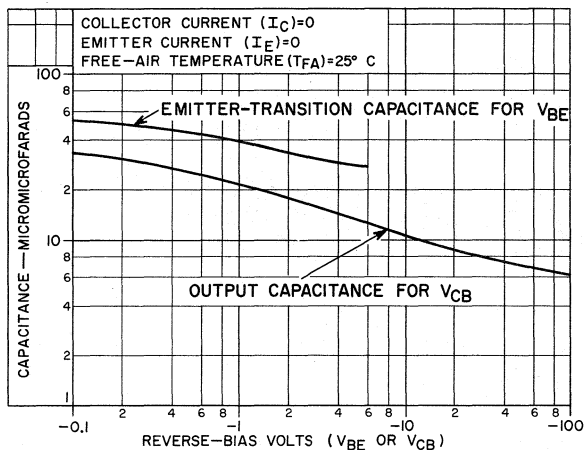
TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



TYPICAL CAPACITANCE CHARACTERISTICS



92CS-III95

Transistor

SILICON N-P-N TRIPLE-DIFFUSED-JUNCTION PLANAR TYPE

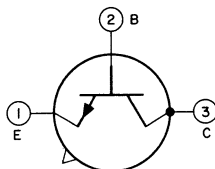
For Small-Signal and Switching Applications
in Industrial and Military Equipment

GENERAL DATA

Mechanical:

Dimensions. See Outline TO-18 in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

INDUSTRIAL SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CBO} 120 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With external resistance between
base and emitter (ohms) ≤ 10 . . . V_{CER} 100 max. volts

With base open. V_{CEO} 80 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EBO} 7 max. volts

TRANSISTOR DISSIPATION:

At case temperatures:^a

From -65° to 25° C. 1.8 max. watts

Above 25° C. Derate linearly 0.0102 watt/ $^{\circ}$ C

At free-air temperatures:

From -65° to 25° C. 0.5 max. watt

Above 25° C. Derate linearly 0.0028 watt/ $^{\circ}$ C

TEMPERATURE:

Operating Range (Junction) T_{opr} -65 to 200 $^{\circ}$ C

Storage Range. T_{stg} -65 to 300 $^{\circ}$ C

Lead:^b

For 10 seconds maximum T_L 255 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, free-air temperature = 25° C

Min. Max.

DC Collector-to-Base Breakdown

Voltage for dc collector ma.

= 0.1, emitter current = 0. . . BV_{CBO} 120 - volts

DC Emitter-to-Base Breakdown

Voltage for dc emitter ma.

= 0.1, collector current = 0. . . BV_{EBO} 7 - volts



2N720A

		Min.	Max.	
DC Collector-to-Emitter Sustaining Voltage:				
With external resistance between base and emitter (ohms) = 10, pulsed-dc collector ma. ^c = 100.	$V_{CER(sus)}$	100	-	volts
With pulse-dc collector ma. ^c = 30, base current = 0.	$V_{CEO(sus)}$	80	-	volts
DC Collector-to-Emitter Saturation Voltage:				
With pulsed-dc collector ma. ^c = 150, pulsed-dc base ma. ^c = 15.	$V_{CE(sat)}$	-	5	volts
With pulsed-dc collector ma. ^c = 50, pulsed-dc base ma. ^c = 5.	$V_{CE(sat)}$	-	1.2	volts
DC Base-to-Emitter Saturation Voltage:				
With pulsed-dc collector ma. ^c = 150, pulsed-dc base ma. ^c = 15.	$V_{BE(sat)}$	-	1.3	volts
With pulsed-dc collector ma. ^c = 50, pulsed-dc base ma. ^c = 5.	$V_{BE(sat)}$	-	0.9	volt
DC Collector-Cutoff Current for dc collector-to-base volts = 90, emitter current = 0, free-air temperature (°C) = 25.	I_{CBO}	-	0.01	μa
150.	I_{CBO}	-	15	μa
DC Emitter-Cutoff Current for dc emitter-to-base volts = 5, collector current = 0.	I_{EBO}	-	0.01	μa
Input Impedance at frequency (kc) = 1:				
With dc collector-to-base volts = 5, dc collector ma. = 1.	h_{ib}	20	30	ohms
With dc collector-to-base volts = 10, dc collector ma. = 5.	h_{ib}	4	8	ohms
Input Capacitance for dc emitter-to-base volts = 0.5, collector current = 0.	C_{ib}	-	85	pf
Output Capacitance for dc collector-to-base volts = 10, emitter current = 0.	C_{ob}	-	15	pf
Output Conductance at frequency (kc) = 1:				
With dc collector-to-base volts = 5, dc collector ma. = 1.	h_{ob}	-	0.5	μmho
With dc collector-to-base volts = 10, dc collector ma. = 5.	h_{ob}	-	0.5	μmho



	Min.	Max.
DC Forward-Current Transfer Ratio for dc collector-to-emitter volts = 10, dc collector ma. =		
0.1	h_{FE} 20	-
10 (Pulsed) ^c	h_{FE} 35	-
150 (Pulsed) ^c	h_{FE} 40	120
10 (Pulsed), ^c free-air temperature (°C) = -55. . .	h_{FE} 20	-
Small-Signal Short-Circuit Forward-Current Transfer Ratio:		
With dc collector-to-emitter volts = 5, dc collector ma. = 1, frequency (kc) = 1.	h_{fe} 30	100
With dc collector-to-emitter volts = 10, dc collector ma. = 5, frequency (kc) = 1	h_{fe} 45	-
With dc collector-to-emitter volts = 10, dc collector ma. = 50, frequency (Mc) = 20.	h_{fe} 2.5	-
Small-Signal Open Circuit Reverse Voltage Transfer (Feedback) Ratio at frequency (kc) = 1:		
With dc collector-to-base volts = 5, dc collector ma. = 1	h_{rb} -	0.000125
With dc collector-to-base volts = 10, dc collector ma. = 5	h_{rb} -	0.00015
Thermal Resistance:		
Junction-to-case	θ_{JC} -	97 °C/watt
Junction-to-free-air	θ_{JFA} -	350 °C/watt

^a Measured at center of seating plane.

^b Measured along lead at distances not less than 1/32" from seating plane.

^c Pulse duration $\leq 300 \mu\text{sec}$, duty factor ≤ 0.02 .



2N720A

OPERATING CONSIDERATIONS

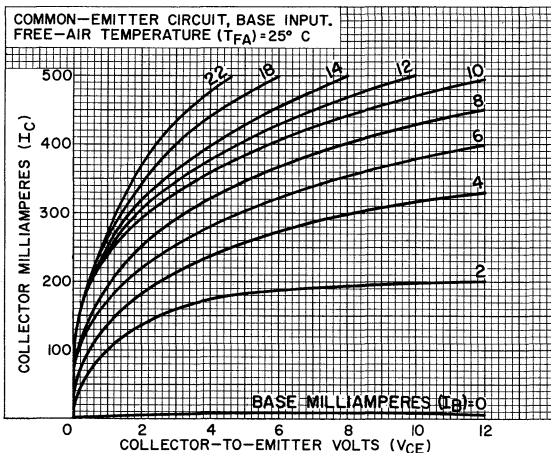
It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

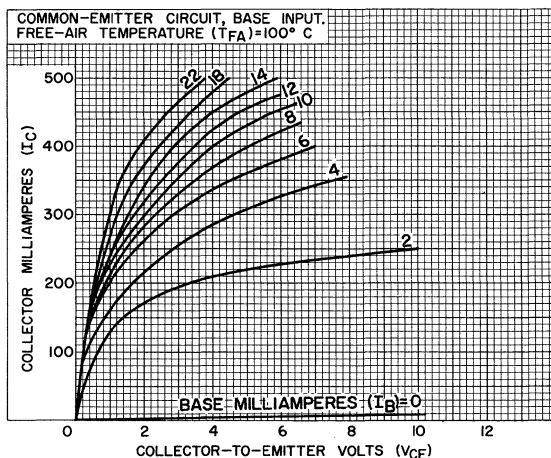
It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



TYPICAL COLLECTOR CHARACTERISTICS



92CS-11189

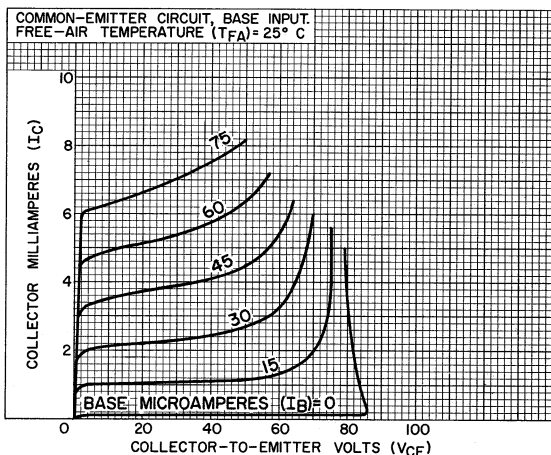


92CS-11177

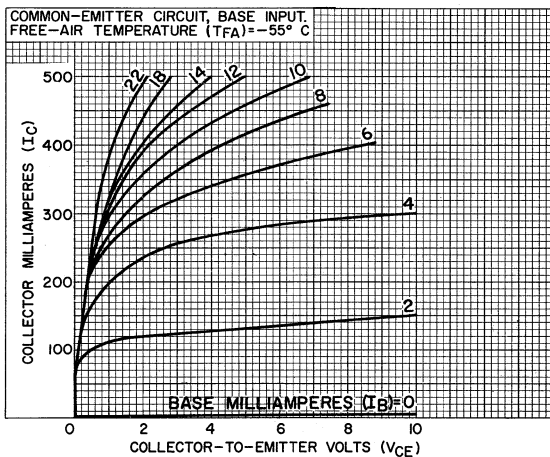


2N720A

TYPICAL COLLECTOR CHARACTERISTICS



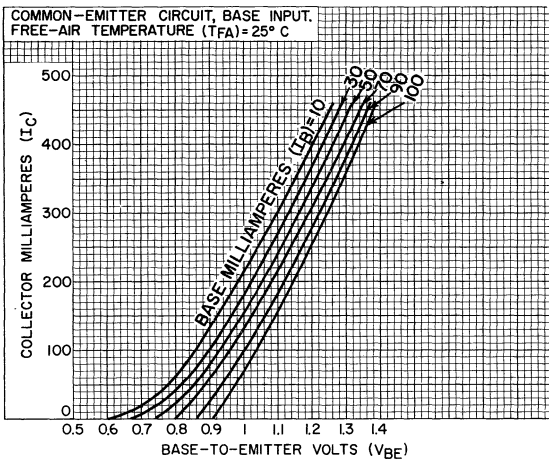
92CS-III75



92CS-III90

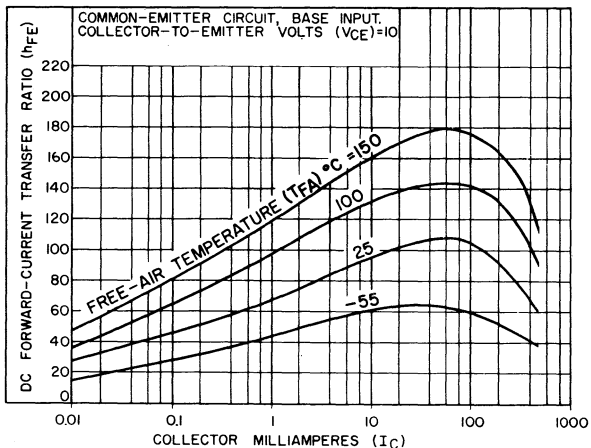


TYPICAL TRANSFER CHARACTERISTICS



92CS-11185

TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS

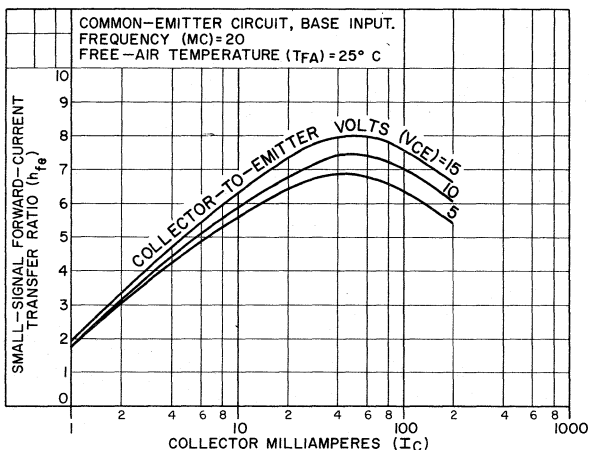


92CS-12115



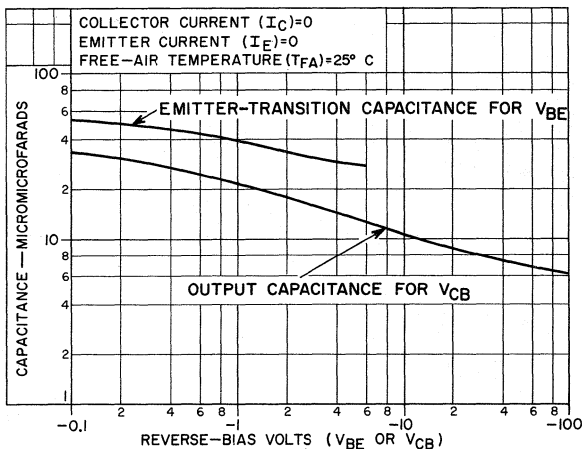
2N720A

TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



92CS-11171

TYPICAL CAPACITANCE CHARACTERISTICS



92CS-11195



Transistor

SILICON N-P-N DOUBLE-DIFFUSED-JUNCTION PLANAR-EPITAXIAL TYPE
For Switching Applications in
Industrial and Military Equipment

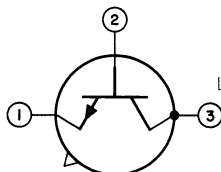
GENERAL DATA

Mechanical:

Dimensions. See *Outline TO-18* in General Section

Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter
 Lead 2 - Base



Lead 3 - Collector,
 Case

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} 40 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With base short-circuited
 to emitter. V_{CES} 30 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EBO} 5 max. volts

COLLECTOR CURRENT I_C 200 max. ma

TRANSISTOR DISSIPATION:^a

At case temperature^b of
 25° C or below. 1 max. watt

At free-air temperature of
 25° C or below. 0.3 max. watt

TEMPERATURE RANGE:

Storage T_{stg} -65 to +175 °C

Operating (Junction). T_J 175 max. °C

LEAD TEMPERATURE:^c

For 10 seconds maximum. T_L 240 max. °C

^a See accompanying *Rating Chart*.

^b Measured at center of seating plane.

^c Measured 1/16" ± 1/32" down from seating plane.



ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and free-air temperature of 25° C unless otherwise specified

Min. Max.

DC Collector Breakdown Voltage for dc collector ma. = 0.1, dc emitter ma. = 0.	BV_{CBO}	40	-	volts
DC Emitter Breakdown Voltage for dc collector ma. = 0, dc emitter ma. = 0.1.	BV_{EBO}	5	-	volts
DC Base-to-Emitter Saturation Voltage for dc collector ma. = 10, dc base ma. = 1	$V_{BE(sat)}$	-	0.9	volt
DC Collector-to-Emitter Saturation Voltage: With dc collector ma. = 10, dc base ma. = 1	$V_{CE(sat)}$	-	0.25	volt
With dc collector ma. = 50, dc base ma. = 5		-	0.4	volt
DC Collector Current with base short circuited to emitter, dc collector-to-emitter volts = 30.	I_{CES}	-	10	μa
DC Collector-Cutoff Current for dc collector volts = 20, dc emitter ma. = 0, free-air temperature = 25° C	I_{CBO}	-	0.5	μa
150° C.		-	30	μa
Collector-to-Base Capacitance for dc collector volts = 10, dc emitter ma. = 0, frequency (kc) = 100.	C_{ob}	-	4	pf
DC Forward-Current Transfer Ratio for dc collector-to-emitter volts = 1, dc collector ma. = 10.	h_{FE}	25	-	
Small-Signal Forward-Current Transfer Ratio for dc collec- tor-to-emitter volts = 15, dc collector ma. = 10, frequency (Mc) = 100.	h_{fe}	3.5	-	
Gain-Bandwidth Product for dc collector-to-emitter volts = 15, dc collector ma. = 10, frequency (Mc) = 100.	f_T	350	-	Mc
Switching Time: Storage time ^d for dc collector supply volts = 10, dc collec- tor ma. = 10, turn-on dc base ma. = 10, turn-off dc base ma. = -10,	t_S	-	25	nsec

Turn-on time ^e (Delay time + rise time) for dc collec- tor ma. = 10.	t_{on}	-	35	nsec
Turn-off time ^e (Storage time + fall time) for dc collec- tor ma. = 10.	t_{off}	-	75	nsec

^d See accompanying *Storage-Time-Measurement Circuit*.

^e See accompanying *Switching-Time-Measurement Circuit*.

PERFORMANCE TESTS

This transistor type meets mechanical and environmental requirements of Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

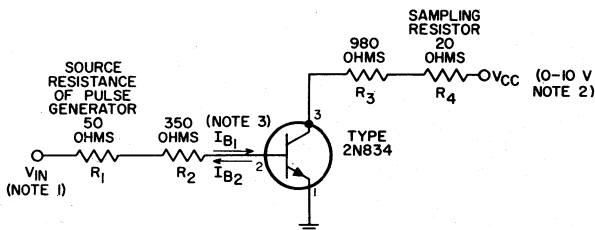
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



2N834

STORAGE-TIME-MEASUREMENT CIRCUIT



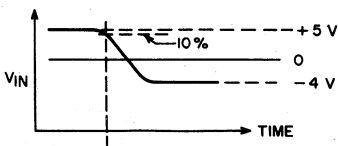
92CS-11577

NOTE 1: TEST CIRCUIT PROVIDED BY THE TEKTRONIX TYPE R PLUG-IN UNIT (FOR TEKTRONIX MODEL 541 OSCILLOSCOPE) FOR THE MEASUREMENT OF t_s . THE TYPE R UNIT PROVIDES THE INPUT VOLTAGE (V_{IN}) AND THE COLLECTOR-SUPPLY VOLTAGE (V_{CC}). RESISTORS R_1 AND R_4 ARE INCLUDED IN THE TYPE R UNIT; RESISTORS R_2 AND R_3 ARE WIRED TO THE ASSOCIATED WIRING BOARD.

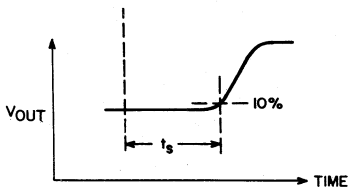
NOTE 2: V_{CC} IS ADJUSTED FOR $I_C = 10$ MA.

NOTE 3: I_{B1} = TURN-ON DC BASE CURRENT
 I_{B2} = TURN-OFF DC BASE CURRENT

ASSOCIATED WAVE FORMS



INPUT WAVE FORM

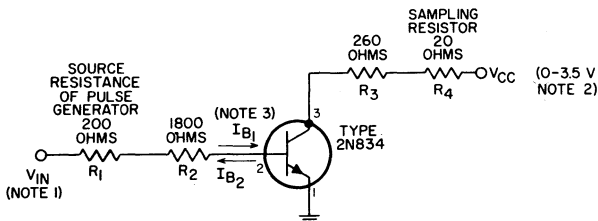


OUTPUT WAVE FORM

92CS-11611



SWITCHING-TIME-MEASUREMENT CIRCUIT



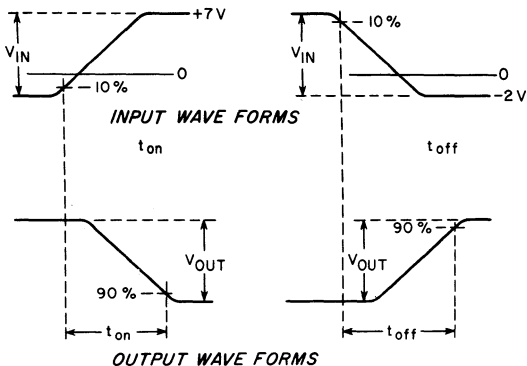
92CS-11578

NOTE 1: TEST CIRCUIT PROVIDED BY THE TEKTRONIX TYPE R PLUG-IN UNIT (FOR TEKTRONIX MODEL 541 OSCILLOSCOPE) FOR THE MEASUREMENT OF SWITCHING TIME. THE TYPE R UNIT PROVIDES THE INPUT VOLTAGE (V_{IN}) AND THE COLLECTOR-SUPPLY VOLTAGE (V_{CC}). RESISTORS R_1 AND R_4 ARE INCLUDED IN THE TYPE R UNIT; RESISTORS R_2 AND R_3 ARE WIRED TO THE ASSOCIATED WIRING BOARD.

NOTE 2: V_{CC} IS ADJUSTED FOR $I_C = 10$ MA.

NOTE 3: I_{B1} = TURN-ON DC BASE CURRENT
 I_{B2} = TURN-OFF DC BASE CURRENT

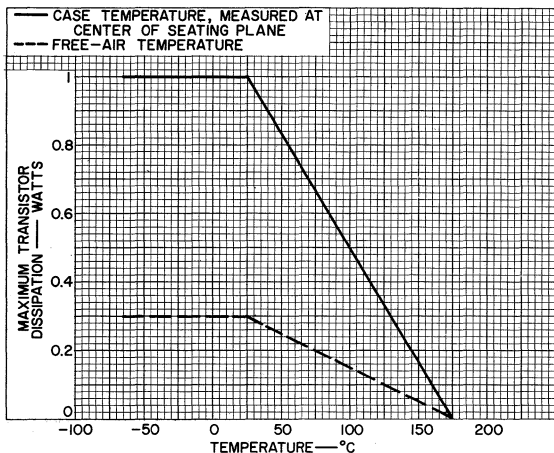
ASSOCIATED WAVE FORMS



92CS-11612



RATING CHART



92CS-11223



Transistor

SILICON N-P-N DOUBLE-DIFFUSED-JUNCTION PLANAR-EPITAXIAL TYPE

For High-Speed Saturated Logic-Switching
and VHF-Amplifier Applications

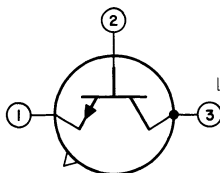
GENERAL DATA

Mechanical:

Dimensions. See *Outline T0-18* in General Section

Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} 40 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With external resistance between base and emitter

(ohms) ≤ 10 V_{CER} 20 max. volts

With base open. V_{CEO} 15 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EBO} 5 max. volts

COLLECTOR CURRENT I_C Limited by power dissipation

TRANSISTOR DISSIPATION:^a

At case temperature^b of

25° C or below. 1.2 max. watts

At free-air temperature of

25° C or below. 0.36 max. watt

TEMPERATURE RANGE:

Storage T_{stg} -65 to +300 °C

Operating (Junction). T_J 200 max. °C

LEAD TEMPERATURE. T_L 300 max. °C

^a See accompanying *Rating Chart*.

^b Measured at center of seating plane.



ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and free-air temperature of 25° C unless otherwise specified

Min. Max.

DC Collector Breakdown Voltage for dc collector ma. = 0.001, dc emitter ma. = 0.	BV_{CBO}	40	-	volts
DC Emitter Breakdown Voltage for dc collector ma. = 0, dc emitter ma. = 0.01.	BV_{EBO}	5	-	volts
DC Collector-to-Emitter Sustaining Voltage for dc- pulse collector ma. = 30: With external resistance between base and emitter (ohms) ≤ 10	$V_{CER(sus)}$	20	-	volts
With base open.	$V_{CEO(sus)}$	15	-	volts
DC Base-to-Emitter Satu- ration Voltage for dc collector ma. = 10, dc base ma. = 1.	$V_{BE(sat)}$	0.7	0.8	volt
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 200, dc base ma. = 20	$V_{CE(sat)}$	-	0.7	volt
DC Collector Current for dc base-to-emitter forward bias volts = 0.25, dc collector-to-emitter volts = 20, free-air temperature = 125° C.	I_{CEX}	-	10	μa
DC Collector-Cutoff Current for dc collector volts = 20, dc emitter ma. = 0, free-air temperature = 25° C.	I_{CBO}	-	0.025	μa
150° C.		-	15	μa
Emitter-to-Base Capacitance for dc emitter volts = -0.5, dc collector ma. = 0, frequency (kc) = 140.	C_{ib}	-	9	pf
Collector-to-Base Capacitance for dc collector volts = 10, dc emitter ma. = 0, frequency (kc) = 140.	C_{ob}	-	6	pf
DC Pulse Forward-Current Transfer Ratio:	h_{FE}			
With dc collector-to- emitter volts = 1, dc collector ma. = 10.		30	120	
With dc collector-to- emitter volts = 5, dc collector ma. = 500		10	-	



Small-Signal Forward-Current
Transfer Ratio for dc
collector-to-emitter volts
= 10, dc collector ma. = 20.

h_{fe} 3 -

Saturation Stored-Charge

Time Constant^c for dc
collector supply volts =
5, collector resistance
(ohms) = 240, dc collec-
tor ma. = 20, turn-on dc
base ma. = 20, turn-off dc
base ma. = 20

τ_s - 20 nsec

Switching Time for dc
collector supply volts =
5, dc collector resistance
(ohms) = 23, dc collector
ma. = 200, turn-on dc base
ma. = 40, turn-off dc base
ma. = 20:

Turn-on time^d (Delay

time + rise time) . . .

t_{on} - 40 nsec

Turn-off time^d (Storage

time + fall time) . . .

t_{off} - 40 nsec

Thermal Resistance:

Junction-to-case.

θ_{J-C} - 145 °C/watt

Junction-to-free-air.

θ_{J-FA} - 480 °C/watt

^c See accompanying *Saturation Stored-Charged Time-Constant Measurement Circuit*.

^d See accompanying *Turn-On-Time and Turn-Off-Time Measurement Circuit*.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

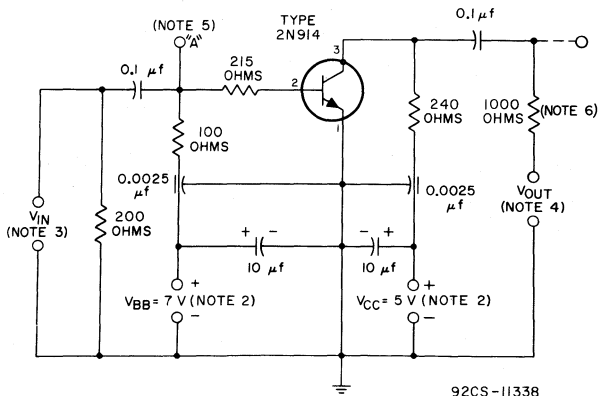
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



2N914

SATURATION STORED-CHARGED TIME-CONSTANT MEASUREMENT CIRCUIT



NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PERCENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT $25\text{-}\mu\text{f}$ DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB} .

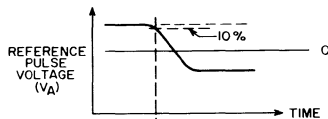
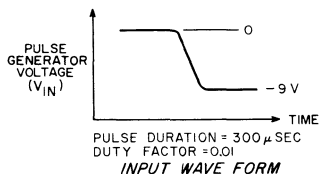
NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS.

NOTE 4: INPUT AND OUTPUT WAVE FORMS SHOWN SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING AN INPUT IMPEDANCE OF 50 OHMS.

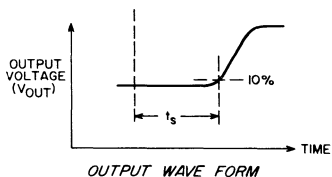
NOTE 5: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

NOTE 6: THIS RESISTOR SHOULD BE OMITTED IF A SAMPLING OSCILLOSCOPE (HAVING A HIGH VALUE OF INPUT IMPEDANCE) IS USED.

ASSOCIATED WAVE FORMS



REFERENCE WAVE FORM OBSERVED AT POINT "A" IN SATURATION STORED-CHARGED TIME-CONSTANT MEASUREMENT CIRCUIT

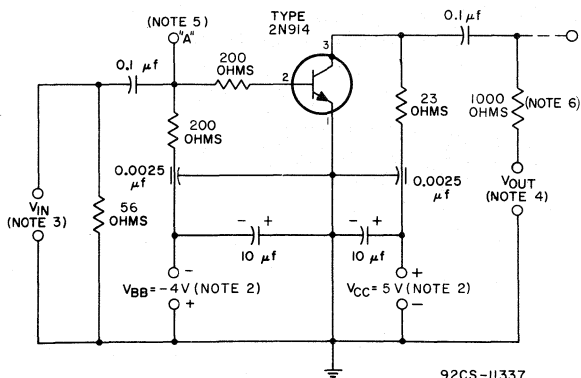


92CS-11339RI



2N914

TURN-ON-TIME AND TURN-OFF-TIME MEASUREMENT CIRCUIT



NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PERCENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT $25\text{-}\mu\text{f}$ DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB} .

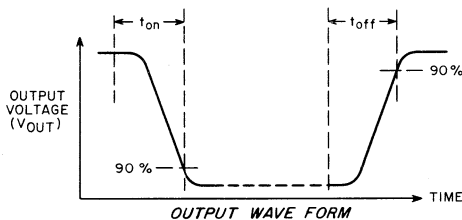
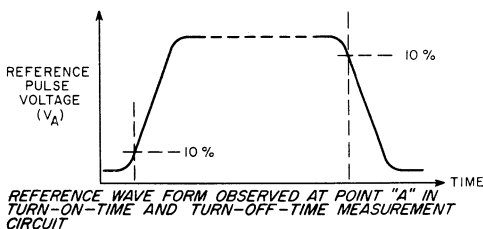
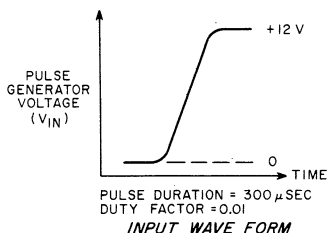
NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS.

NOTE 4: INPUT AND OUTPUT WAVE FORMS SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING AN INPUT IMPEDANCE OF 50 OHMS.

NOTE 5: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).

NOTE 6: THIS RESISTOR SHOULD BE OMITTED IF A SAMPLING OSCILLOSCOPE (HAVING A HIGH VALUE OF INPUT IMPEDANCE) IS USED.

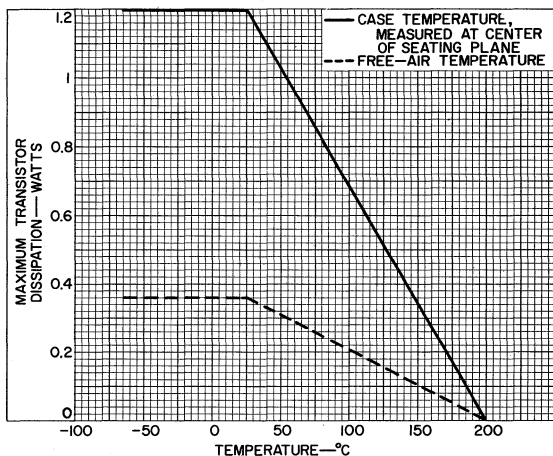
ASSOCIATED WAVE FORMS



92CS-11330RI



RATING CHART



92CS-11231R1



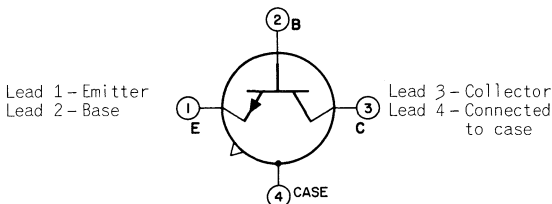
Transistors

SILICON N-P-N EPITAXIAL-PLANAR TYPES 4-LEAD "TO-18" TYPE CASE

*For Low-Noise Amplifier, Oscillator, and Converter
Applications at VHF Frequencies in Military,
Communications and Industrial Equipment*

Dimensions See accompanying Dimensional Outline

Terminal Diagram: **BOTTOM VIEW**



MAXIMUM RATINGS, Absolute-Maximum Values

		2N917	2N918	
Collector-to-Base Voltage.	V_{CBO}	30	30	volts
Collector-to-Emitter Voltage.	V_{CEO}	15	15	volts
Emitter-to-Base Voltage.	V_{EB0}	3	3	volts
Collector Current.	I_C	a	50	ma

Transistor Dissipation

At case temperatures with heat sink:^b

From -65° to 25°C.	P_T	300	300	mw
Above 25°C.	Derate linearly	1.71	mw/°C	

Temperature Range

Operating (Junction)	T_{opr}	-65 to 200	°C
Storage	T_{stg}	-65 to 200	°C
Lead-Soldering Temperature ^C	T_L	300 300	°C

(For 60 sec. max.)

ELECTRICAL CHARACTERISTICS

*Unless otherwise specified, electrode-voltage and
electrode-current values for given test conditions
are dc at free-air temperature = 25°C*

2N917 2N918

Collector-to-Base Breakdown

Voltage.	BV_{CBO}	30	30	min. volts
$I_C = 0.001$ ma, $I_E = 0$				

Emitter-to-Base Breakdown

Voltage.	BV_{EB0}	3	3	min. volts
$I_E = 0.01$ ma, $I_C = 0$				



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DATA 1
4-65

2N917, 2N918

2N917 2N918

Collector-to-Emitter

Sustaining Voltage. . . . $BV_{CE0(sus)}$ 15 15 min. volts
 $I_C = 3 \text{ ma}$, $I_B = 0$

Base-to-Emitter

Saturation Voltage
 $I_C = 3 \text{ ma}$, $I_B = 0.15 \text{ ma}$. . . $V_{BE(sat)}$ 0.87 - max. volt
 $I_C = 10 \text{ ma}$, $I_B = 1 \text{ ma}$. . . $V_{BE(sat)}$ - 1 max. volt

Collector-to-Emitter

Saturation Voltage
 $I_C = 3 \text{ ma}$, $I_B = 0.15 \text{ ma}$. . . $V_{CE(sat)}$ 0.5 - max. volt
 $I_C = 10 \text{ ma}$, $I_B = 1 \text{ ma}$. . . $V_{CE(sat)}$ - 0.4 max. volt

Collector-Cutoff Current

$V_{CB} = 15 \text{ volts}$, $I_E = 0$,
 $T_{FA} = 25^\circ\text{C}$ I_{CBO} 0.001 0.01 max. μa
 $T_{FA} = 150^\circ\text{C}$ I_{CBO} 0.1 1 max. μa

DC Forward-Current

Transfer Ratio
 $V_{CE} = 1 \text{ volt}$, $I_C = 3 \text{ ma}$. . . h_{FE} 20 20 min.
 h_{FE} 200 - max.

Small-Signal Forward-

Current Transfer Ratio^d. . . h_{fe} 5 6 min.
 $f = 100 \text{ Mc}$, $V_{CE} = 10 \text{ volts}$,
 $I_C = 4 \text{ ma}$

Input Capacitance^e.

$f = 0.1 \text{ to } 1 \text{ Mc}$, $V_{EB} = 0.5$
volts, $I_C = 0$ C_{ib} 1.6 2 max. pf

Output Capacitance^e

$f = 0.1 \text{ to } 1 \text{ Mc}$, $I_E = 0$,
 $V_{CB} = 10 \text{ volts}$ C_{ob} 1.7 1.7 max. pf
 $V_{CB} = 0$ C_{ob} - 3 max. pf

Collector-to-Base Time

Constant^d
 $f = 40 \text{ Mc}$,
 $V_{CB} = 6 \text{ volts}$, $I_C = 2 \text{ ma}$ $r_b'C_c$ - 15 typ. psec
 $V_{CB} = 10 \text{ volts}$, $I_C = 4 \text{ ma}$ $r_b'C_c$ 30 - typ. psec
 $V_{CB} = 10 \text{ volts}$, $I_C = 4 \text{ ma}$ $r_b'C_c$ 75 - max. psec

Small-Signal Power Gain

UNNEUTRALIZED AMPLIFIER
CIRCUIT^{d,f}

$f = 200 \text{ Mc}$, $V_{CE} = 10 \text{ volts}$,
 $I_C = 5 \text{ ma}$ G_{pe} 9 - min. db
 G_{pe} 11.5 13 typ. db

NEUTRALIZED AMPLIFIER CIRCUIT^{d,g}

$f = 200 \text{ Mc}$, $V_{CE} = 12 \text{ volts}$,
 $I_C = 6 \text{ ma}$ G_{pe} - 15 min. db
 G_{pe} - 18 typ. db

Power Output

OSCILLATOR CIRCUIT^{e,h}

$f = 500 \text{ Mc}$,
 $V_{CB} = 15 \text{ volts}$, $I_E = 8 \text{ ma}$ P_o 10 - min. mw
 $V_{CB} = 10 \text{ volts}$, $I_E = 12 \text{ ma}$ P_o - 30 min. mw

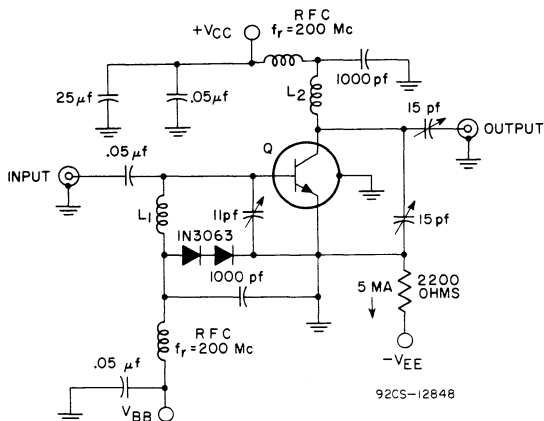


		2N917	2N918		
Noise Figure ^d	NF ^f	3.5	3	typ.	db
$f = 60 \text{ Mc}$, $V_{CE} = 6 \text{ volts}$,					
$I_C = 1 \text{ ma}$, $R_{GJ} = 400 \text{ ohms}$. . .	NF	6	6	max.	db

- a Limited by transistor dissipation.
- b Measured at center of seating surface.
- c Measured along lead at distances greater than 1/16 inch from seating surface.
- d Fourth lead (case) grounded.
- e Fourth lead (case) floating.
- f See accompanying *Unneutralized Power Gain Circuit*.
- g See accompanying *Neutralized Power Gain Circuit*.
- h See accompanying *Oscillator Circuit*.
- j R_G = Generator resistance.

All curves shown under type 2N3600
also apply to the 2N918.

POWER GAIN TEST CIRCUIT Unneutralized Amplifier, 200-Mc (2N917, 2N918)



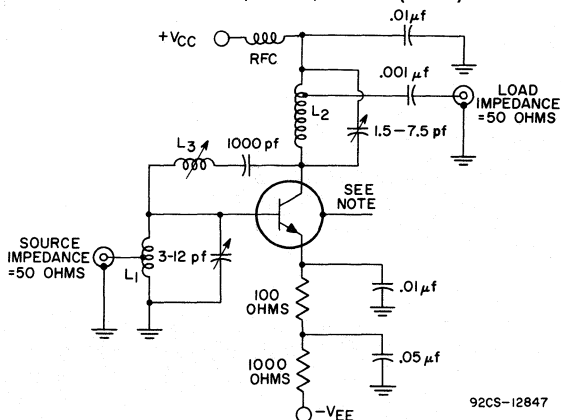
- Q = Type 2N917 or 2N918
- L₁ = 1 Loop #12 ga
- L₂ = 1/2 Loop #12 ga
- I_D = 13/16"
- I_D = 1-3/16"



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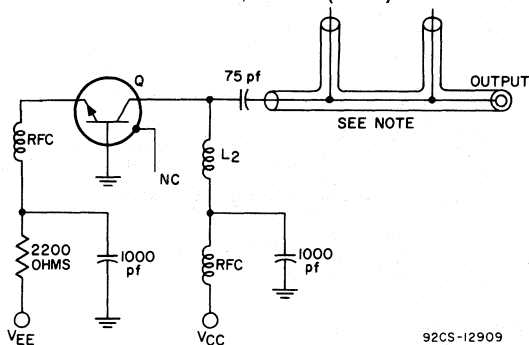
DATA 2
4-65

POWER GAIN TEST CIRCUIT Neutralized Amplifier, 200-Mc (2N918)



- L_1 - 3.5 Turns No. 16 tinned copper wire; 5/16" Dia; 7/16" Long
 L_2 - 8 Turns No. 16 tinned copper wire; 1/8" Dia; 7/8" Long
 L_3 - MILLER #4303 (.4-.65 μ h) or equivalent
Note: 2N918, Lead Number 4 (case) Floating

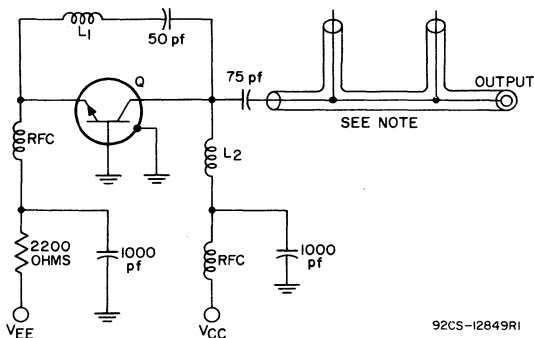
POWER OUTPUT TEST CIRCUIT Oscillator, 500-Mc (2N917)



- Note:** Coaxial-Line output network consisting of:
 2 General Radio Type 874 TEE or equivalent
 1 General Radio Type 874-D20 adjustable stub or equivalent
 1 General Radio Type 874-LA adjustable line or equivalent
 1 General Radio Type 874-WN3 short-circuit termination or equivalent
 L_2 = 2 turns #16 AWG wire, 3/8 inch OD, 1-1/4 inch long



POWER OUTPUT TEST CIRCUIT Oscillator, 500-Mc (2N918)



92CS-12849RI

Note: Coaxial-Line output network consisting of:

2 General Radio Type 874 TEE or equivalent

1 General Radio Type 874-D20 adjustable stub or equivalent

2 General Radio Type 874-LA adjustable line or equivalent

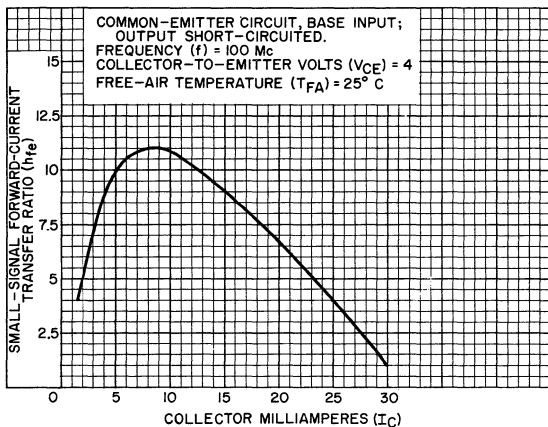
1 General Radio Type 874-WN3 short-circuit termination or equivalent

L_1 = 9 turns #16 AWG wire, 3/8 inch OD, 1-1/4 inch long or equivalent

L_2 = 2 turns #16 AWG wire, 3/8 inch OD, 1-1/4 inch long or equivalent

Q = 2N918

Small-Signal Beta (h_{fe}) Characteristics 2N917



92CS-12846



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Electronic Components and Devices
Harrison, N. J.

DATA 3
4-65



2N1010

2N1010

JUNCTION TRANSISTOR

GERMANIUM N-P-N ALLOY TYPE

For use in input stages of audio-frequency amplifiers operating from extremely small input signals such as high-fidelity preamplifiers, tape recorders, microphone preamplifiers, and hearing aids where low noise is an important design consideration.

GENERAL DATA

Electrical, At Ambient Temperature of 25° C:

Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = 10 with emitter open.	10	μ a
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = 2.5 with collector open	6	μ a

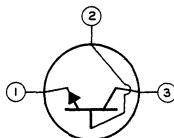
Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.405"
Maximum Diameter.	0.240"
Dimensional Outline	JEDEC No. TO-1
Case.	Metal
Envelope Seals.	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline
Base.	JEDEC No. E3-39

BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector
(Adjacent
to red dot
on side of
case)

AUDIO-FREQUENCY AMPLIFIER — Class A

Maximum Ratings, Absolute Values:

PEAK COLLECTOR-TO-BASE VOLTAGE.	10 max.	volts
PEAK COLLECTOR-TO-EMITTER VOLTAGE	10 max.	volts
PEAK EMITTER-TO-BASE VOLTAGE.	10 max.	volts
PEAK COLLECTOR CURRENT.	2 max.	ma
PEAK EMITTER CURRENT.	-2 max.	ma
TRANSISTOR DISSIPATION:		
At ambient temperature of 55° C or below.	20 max.	mw
AMBIENT TEMPERATURE (During operation).	55 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C



2N1010

JUNCTION TRANSISTOR

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage	3.5	volts
DC Emitter Current	-0.3	ma
Typical Small-Signal Current Gain (h_{fe}) [■]	35	

Maximum Noise Factor:

With generator resistance (ohms) = 1000, and integrated noise bandwidth (kc) = 15.	5	db
---	---	----

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	6	volts
DC Collector Current	1	ma
Alpha-Cutoff Frequency	2	Mc

■ Measured at 1 kc.

OPERATING CONSIDERATIONS

The 2N1010 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N1010 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise the heat of the soldering operation will crack the seals of the leads and damage the transistor.

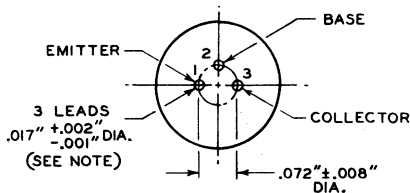
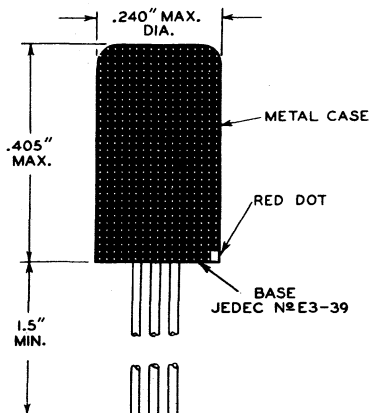
When dip soldering is employed in the assembly of printed circuitry using the 2N1010, the temperature of the solder should not exceed 255°C for a maximum immersion period of 10 seconds.



2N1010

2N1010

JUNCTION TRANSISTOR



92CS-9148R4

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

2N1010

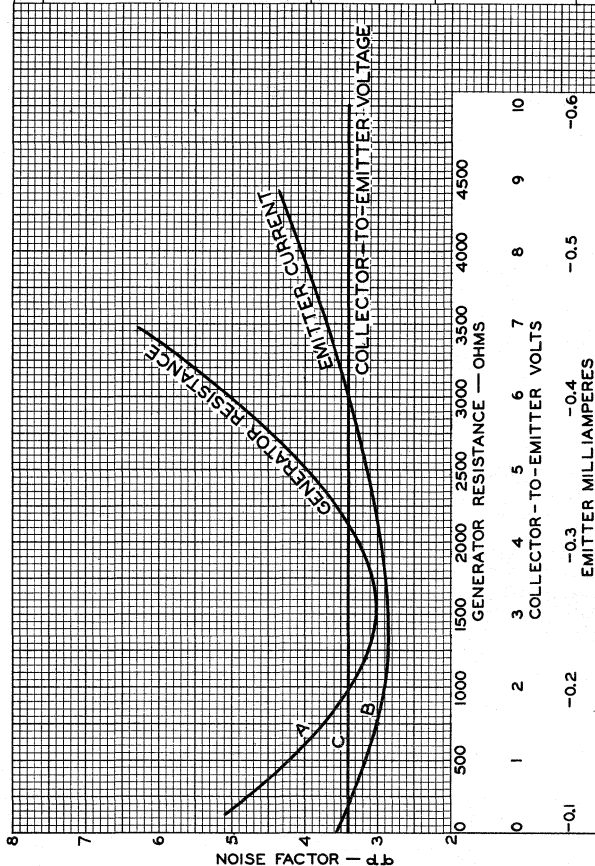


2N1010

AVERAGE NOISE CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
 AMBIENT TEMPERATURE = 25° C
 INTEGRATED NOISE BANDWIDTH = 15 KC

CURVE	GENERATOR RESISTANCE—OHMS	EMITTER MILLI-AMPERES	COLLECTOR-TO-EMITTER VOLTS
A	—	-0.3	3.5
B	1000	—	3.5
C	1000	-0.3	—



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE
For Industrial and Military Applications

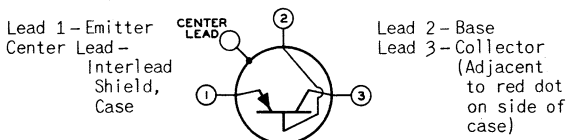
GENERAL DATA

Mechanical:

Operating Position	Any
Maximum Length (Excluding flexible leads)	0.405"
Maximum Diameter	0.240"
Dimensional Outline	JEDEC No. TO-44
Case	Metal
Seals	Hermetic
Leads, Flexible	.4
Minimum length	1.5"
Orientation and diameter	See Dimensional Outline

Terminal Diagram:

BOTTOM VIEW



INDUSTRIAL SERVICE

Such as in rf, if, oscillator, mixer, converter, and low-level video-amplifier circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE (Emitter open)	-40 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE (Base-to-emitter volts = 0.5)	-40 max.	volts
EMITTER-TO-BASE VOLTAGE	-0.5 max.	volt
COLLECTOR CURRENT	-10 max.	ma
EMITTER CURRENT	10 max.	ma
TRANSISTOR DISSIPATION (See Rating Chart): At ambient temperature of 25° C for operation in free air	120 max.	ma
At case temperature of 25° C for operation with heat sink	240 max.	ma
AMBIENT-TEMPERATURE RANGE: Operating and storage	-65 to +100	°C

Typical Operation:

In accompanying video-amplifier circuit with ambient temperature range of -65 to +55° C

DC Collector-to-Emitter Voltage	-12	volts
DC Emitter Current	5.8	ma
Source Impedance	150	ohms
Capacitive Load	16	μuf



2N1023

Frequency-Response Range:

Minimum.	20	cps
Maximum.	11	Mc
Pulse-Rise Time.	0.032	μ sec
Voltage Gain	26	db
Maximum Peak-to-Peak Output Voltage. . . .	20	volts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base unless otherwise specified. Ambient temperature = 25° C.

	Typical Values	Range Values		
		Min.	Max.	
DC Collector Breakdown Voltage (BV_{CBO}) with dc collector $\mu a = -50$, dc emitter $ma. = 0$	-80	-40	-	volts
Punch-Through Voltage (V_P) with dc emitter volts = -0.5	-80	-40	-	volts
DC Collector-Cutoff Current (I_{CBO}) with dc collector volts = -12, dc emitter $ma. = 0$	-4	-	-12	μa
DC Emitter-Cutoff Current (I_{EBO}) with dc emitter volts = -0.5, collector open	-1	-	-12	μa
Small-Signal Current Transfer Ratio (h_{fe}) for dc collec- tor-to-emitter volts = -12, dc emitter $ma. = 1.5$, signal frequency of 1 kc	60	20	175	
Alpha-Cutoff Frequency (f_{ab}) for dc collector volts = -12, dc emitter $ma. = 1.5$	30	-	-	Mc
Input Resistance (R_{in}): Δ For dc collector volts = -12, dc emitter $ma. =$ 1.5, signal frequency of 50 Mc	25	-	-	ohms
For dc collector-to-emitter volts = -12, dc emitter $ma. = 1.5$, signal frequency of 30 Mc	100	-	-	ohms
Output Resistance (R_{out}): $\bullet$ For dc collector volts = -12, dc emitter $ma. =$ 1.5, signal frequency of 50 Mc	8000	-	-	ohms
For dc collector-to-emitter volts = -12, dc emitter $ma. = 1.5$, signal frequency of 30 Mc	8000	-	-	ohms



	Typical Values	Range Values	
		Min.	Max.
Collector-to-Base Capacitance (C_{ob}) for dc collector volts = -12, dc emitter ma. = 0	2	-	3 μmf
Power Gain (PG): For dc collector volts = -12, dc emitter ma. = 1.5, signal frequency of 50 Mc	21	18	24 db
For dc collector-to-emitter volts = -12, dc emitter ma. = 1.5, signal frequency of 30 Mc . . .	23	20	26 db
Thermal Resistance (R_T): Between junction and case.	-	-	0.31 $^{\circ}\text{C/watt}$
Between junction and free air	-	-	0.62 $^{\circ}\text{C/watt}$

▲ AC output circuit shorted.

● AC input circuit shorted.

■ Measured in a single-tuned unilateralized circuit matched to the generator and load impedance for maximum transfer of power (transformer-insertion losses not included).

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.

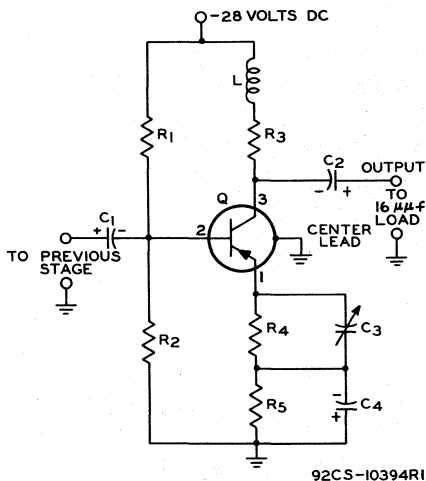
When dip soldering is employed in the assembly of printed circuitry using this transistor, the temperature of the solder should not exceed 255°C for a maximum immersion period of 10 seconds.

This transistor utilizes shielding to minimize interlead capacitance and coupling to adjacent circuit components. This shielding is provided by a fourth lead which is internally connected to the case. For optimum performance, it is recommended that this lead be connected to the chassis ground.



2N1023

VIDEO-AMPLIFIER CIRCUIT

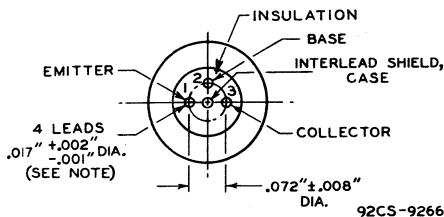


- C_1 : 25 μ f, 12 volts
 C_2 : 25 μ f, 25 volts
 C_3 : 100 to 300 μ f (variable)
 C_4 : 100 μ f, 12 volts
 L : 30 μ h
 Q : Transistor type 2N1023
 R_1 : 20,000 ohms, 0.25 watt
 R_2 : 3600 ohms, 0.25 watt
 R_3 : 2000 ohms, 0.25 watt
 R_4 : 62 ohms, 0.25 watt
 R_5 : 620 ohms, 0.25 watt

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Technical drawing of a 100 ohm 1/4 watt resistor. The drawing shows a cylindrical body with a diameter of .240 inches maximum. The length of the body is .405 inches maximum. The leads are 1.5 inches minimum long. A red dot is located on the side of the body. The drawing is labeled "100 OHM 1/4 WATT" and "RED DOT".



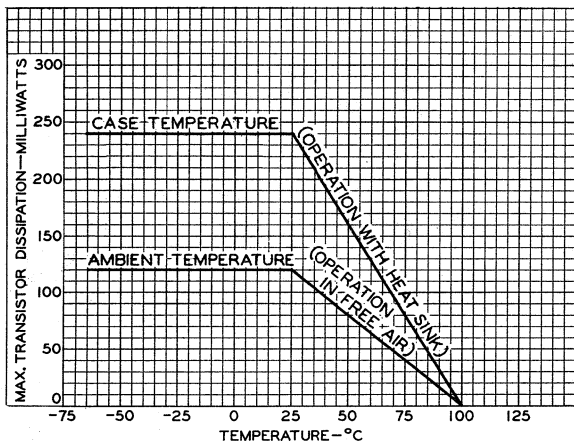
NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE PLANE OF THE ACTUAL BOTTOM OF THE CASE BETWEEN 0.250" AND 1.50", A MAXIMUM OF 0.021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



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Semiconductor & Materials Division Somerville, N. J.

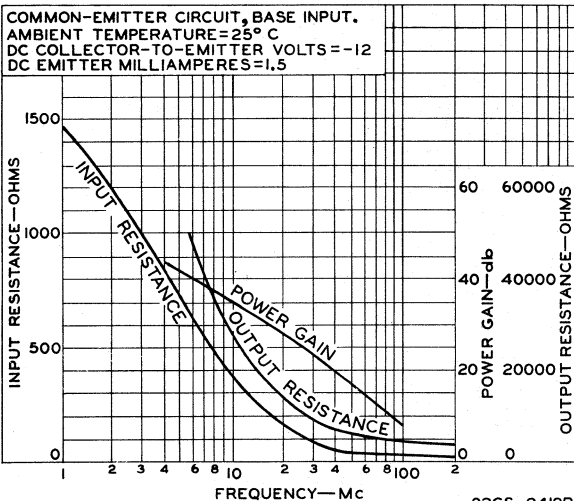
DATA 3
3-60

RATING CHART



92CS-1038IRI

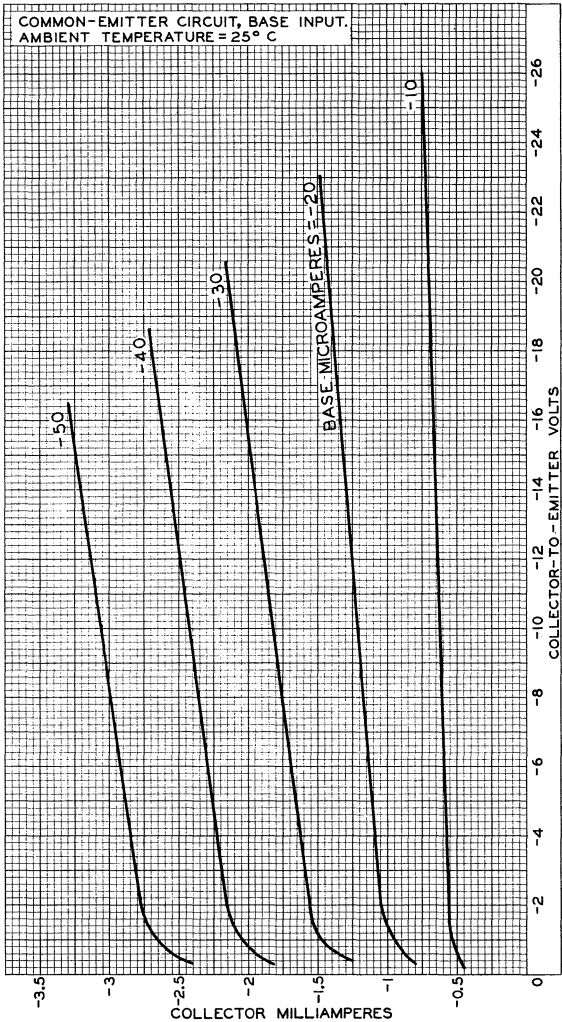
PERFORMANCE CHARACTERISTICS



92CS-9419RI



TYPICAL COLLECTOR CHARACTERISTICS



92CM-9418



RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

DATA 4
3-60

Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE
For Industrial and Military Applications

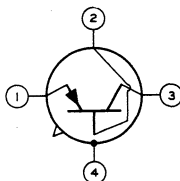
The 2N1066 is the same as the 2N1023 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-33
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector
Lead 4 - Interlead
Shield,
Case

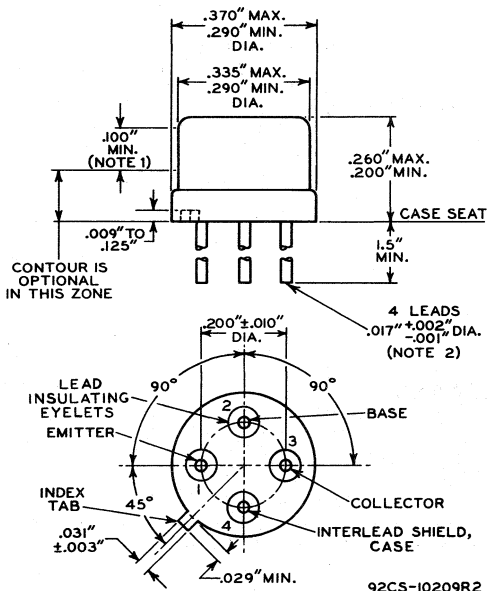
OPERATING CONSIDERATIONS

shown under Type 2N1023 also apply to the 2N1066
with the addition of the following:

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar stand-off device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.



2N1066



NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



2N1090

2N1090

JUNCTION TRANSISTOR

GERMANIUM N-P-N ALLOY TYPE

For switching applications

GENERAL DATA

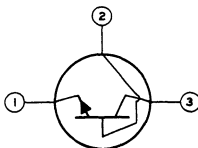
Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. T0-9
Case.	Metal
Envelope Seals.	Welded, Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline
Base.	JEDEC No. E3-51

BOTTOM VIEW

Lead 1- Emitter

Lead 3- Collector



Lead 2- Base

SWITCHING SERVICE

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE (Emitter open).	25 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE (Base-to-emitter volts = -1).	18 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE (Base open).	15 max.	volts
EMITTER-TO-BASE VOLTAGE	20 max.	volts
COLLECTOR CURRENT	400 max.	ma
EMITTER CURRENT	-400 max.	ma
TRANSISTOR TOTAL DISSIPATION:*		
At ambient temperature of 25° C	120 max.	mW
At ambient temperature of 55° C	35 max.	mW
At ambient temperature of 71° C	10 max.	mW
AMBIENT TEMPERATURE (During operation).	85 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C

Typical Operation:

In accompanying inverter circuit

Collector Supply Voltage.	10	volts
Collector Current (Transistor "on")	200	ma
Base Current:		
"Turn-on" (I_{B1})	20	ma
"Turn-off" (I_{B2})	-20	ma
Switching Time:		
Delay time (t_d)	0.05	μ sec

* See Rating Chart.



2N1090

JUNCTION TRANSISTOR

Rise time (t_r)	0.25 μ sec
Storage time (t_s)	0.2 μ sec
Fall time (t_f)	0.15 μ sec

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base unless otherwise specified. Ambient temperature = 25° C.

	Typical Values	Range Values		
		Min.	Max.	
DC Collector Breakdown Voltage (BV_{CBO}) with dc collector $\mu a = 25$, and dc emitter current = 0 . . .	40	25	—	volts
DC Emitter Breakdown Voltage (BV_{EBO}) with dc emitter $\mu a = 25$, and dc collector current = 0 . .	40	20	—	volts
DC Collector-to-Emitter Breakdown Voltage (BV_{CEO}) with dc collector $\mu a =$ 600, and dc base current = 0	27	15	—	volts
Punch-Through Voltage (V_p) with dc emitter volts = 1	40	18	—	volts
DC Base-to-Emitter Voltage (V_{BE}): With dc collector ma. = 20, and dc base ma. = 0.67	0.28	—	0.4	volt
With dc collector ma. = 200, and dc base ma. = 10	0.85	—	1.5	volts
DC Collector-to-Emitter Saturation Voltage (V_{CE}): With dc collector ma. = 20, and dc base ma. = 0.67	0.09	—	0.2	volt
With dc collector ma. = 200, and dc base ma. = 10	0.22	—	0.3	volt
DC Collector-Cutoff Current (I_{CBO}) with dc collector volts = 12, and dc emitter current = 0	4	—	8	μa
DC Emitter-Cutoff Current (I_{EBO}) with dc emitter volts = 5, and dc collector current = 0	1.5	—	5	μa



2N1090

2N1090

JUNCTION TRANSISTOR

	Typical Values	Range Values	
		Min.	Max.
DC Current Gain (h_{FE}):			
With dc collector-to-emitter volts = 0.2, and dc collector ma. = 20.	50	30	-
With dc collector-to-emitter volts = 0.3, and dc collector ma. = 200.	35	20	-
Alpha-Cutoff Frequency ($F_{\alpha b}$) with dc collector volts = 6, and dc emitter ma. = -1.	7	5	-
Collector-to-Base Capacitance (C_{ob}) with dc collector volts = 6, and dc emitter current = 0	17	-	25 μf
Stored Base Charge (Q_S) with dc collector ma. = 20, and dc base ma. = 1.33.	1000	-	1600 $\mu\text{coulombs}$

OPERATING CONSIDERATIONS

It is recommended that the 2N1090 not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N1090 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N1090, the temperature of the solder should not exceed 255°C for a maximum immersion period of 10 seconds.

The 2N1090 is intended for use in single-side printed-circuit boards and in conventional wire-in-type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.

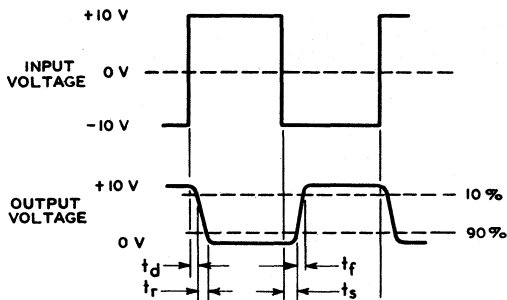
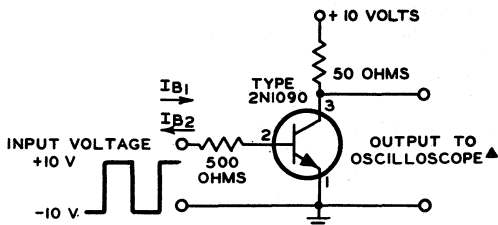
2N1090



2N1090

JUNCTION TRANSISTOR

INVERTER CIRCUIT



92CS-10017

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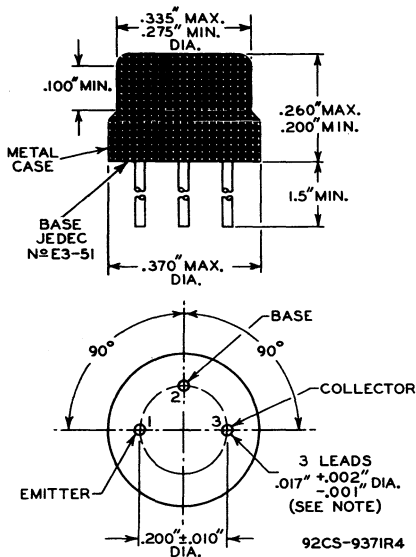
▲ Input resistance and capacitance with probe: 10 megohms shunted by 15 μ t.



2N1090

2N1090

JUNCTION TRANSISTOR



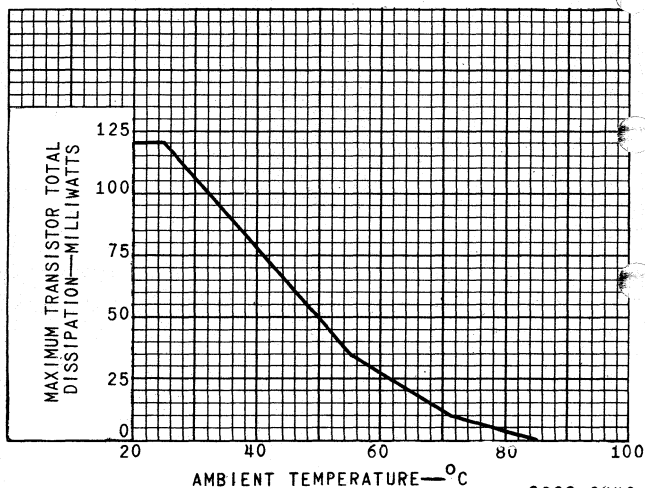
NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.050" AND 0.250" FROM THE BASE SEAT. BETWEEN 0.250" AND 1.50", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

2N1090



2N1090

RATING CHART



92CS-9449

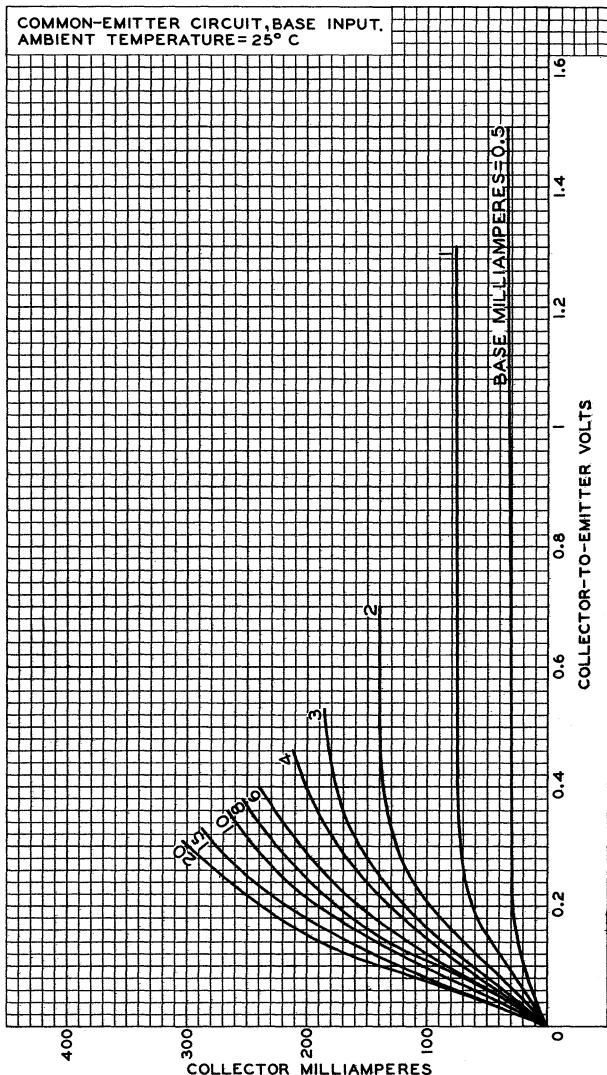


2N1090

2N1090

TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT,
AMBIENT TEMPERATURE = 25° C



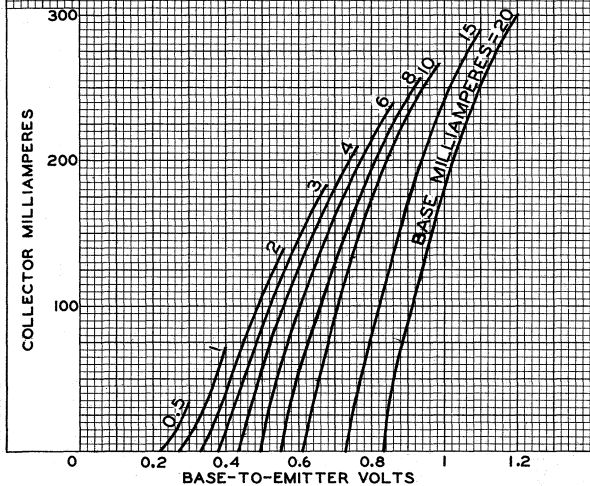
2N1090



2N1090

TYPICAL TRANSFER CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE = 25° C





2N1091

2N1091

JUNCTION TRANSISTOR

GERMANIUM N-P-N ALLOY TYPE

For switching applications

GENERAL DATA

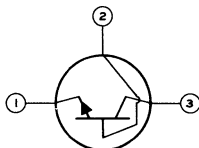
Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-9
Case.	Metal
Envelope Seals.	Welded, Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See Dimensional Outline
Base.	JEDEC No. E3-51

BOTTOM VIEW

Lead 1 - Emitter

Lead 3 - Collector



Lead 2 - Base

SWITCHING SERVICE

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE (Emitter open)	25 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE (Base-to-emitter volts = -1)	15 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE (Base open)	12 max.	volts
EMITTER-TO-BASE VOLTAGE	20 max.	volts
COLLECTOR CURRENT	400 max.	ma
EMITTER CURRENT	-400 max.	ma
TRANSISTOR TOTAL DISSIPATION:*		
At ambient temperature of 25° C	120 max.	mw
At ambient temperature of 55° C	35 max.	mw
At ambient temperature of 71° C	10 max.	mw
AMBIENT TEMPERATURE (During operation)	85 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C

Typical Operation:

In accompanying inverter circuit

Collector Supply Voltage.	10	volts
Collector Current (Transistor "on")	200	ma
Base Current:		
"Turn-on" (I_{B1})	13.3	ma
"Turn-off" (I_{B2})	-13.3	ma
Switching Time:		
Delay time (t_d)	0.05	μ sec

* See Rating Chart.

8-59

SEMICONDUCTOR and MATERIALS DIVISION
RADIO CORPORATION OF AMERICA, SOMERVILLE, NEW JERSEY

DATA 1



JUNCTION TRANSISTOR

Rise time (t_r)	0.2	μsec
Storage time (t_s)	0.17	μsec
Fall time (t_f)	0.13	μsec

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base unless otherwise specified. Ambient temperature = 25°C .

	Typical Values	Range Values		
		Min.	Max.	
DC Collector Breakdown Voltage (BV_{CBO}) with dc collector $\mu_a = 25$, and dc emitter current = 0	40	25	—	volts
DC Emitter Breakdown Voltage (BV_{EBO}) with dc emitter $\mu_a = 25$, and dc collector current = 0	40	20	—	volts
DC Collector-to-Emitter Breakdown Voltage (BV_{CEO}) with dc collector $\mu_a = 600$, and dc base current = 0	25	12	—	volts
Punch-Through Voltage (V_P) with dc emitter volts = 1	40	15	—	volts
DC Base-to-Emitter Voltage (V_{BE}): With dc collector ma. = 20, and dc base ma. = 0.5	0.27	—	0.35	volt
With dc collector ma. = 200, and dc base ma. = 6.7	0.66	—	1.1	volts
DC Collector-to-Emitter Saturation Voltage (V_{CE}): With dc collector ma. = 20, and dc base ma. = 0.5	0.09	—	0.2	volt
With dc collector ma. = 200, and dc base ma. = 6.7	0.2	—	0.3	volt
DC Collector-Cutoff Current (I_{CBO}) with dc collector volts = 12, and dc emitter current = 0	4	—	8	μa
DC Emitter-Cutoff Current (I_{EBO}) with dc emitter volts = 5, and dc collector current = 0	1.5	—	5	μa
DC Current Gain (h_{FE}): With dc collector-to-emitter volts = 0.2, and dc collector ma. = 20	70	40	—	
With dc collector-to-emitter volts = 0.3, and dc collector ma. = 200	55	30	—	



2N1091

2N1091

JUNCTION TRANSISTOR

	Typical Values	Range Values	
		Min.	Max.
Alpha-Cutoff Frequency ($F_{\alpha b}$) with dc collector volts = 6, and dc emitter ma. = -1.	13	10	-
Collector-to-Base Capaci- tance (C_{ob}) with dc collector volts = 6, and dc emitter current = 0. . .	17	-	25
Stored Base Charge (Q_S) with dc collector ma. = 20, and dc base ma. = 1 . .	750	-	1000
			$\mu\text{coulombs}$

OPERATING CONSIDERATIONS

It is recommended that the 2N1091 not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of the 2N1091 are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using the 2N1091, the temperature of the solder should not exceed 255°C for a maximum immersion period of 10 seconds.

The 2N1091 is intended for use in single-side printed-circuit boards and in conventional wire-in-type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.

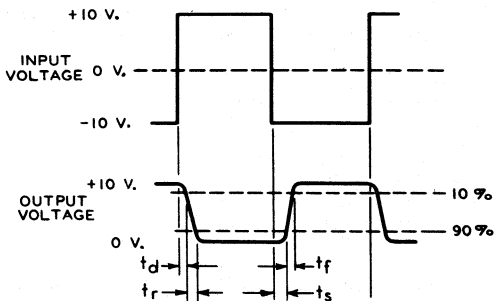
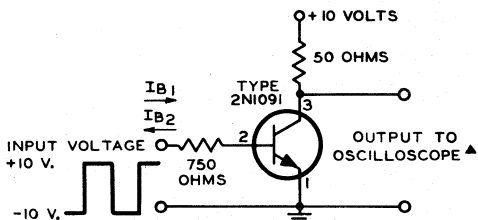
2N1091



2N1091

JUNCTION TRANSISTOR

INVERTER CIRCUIT



92CS-10022

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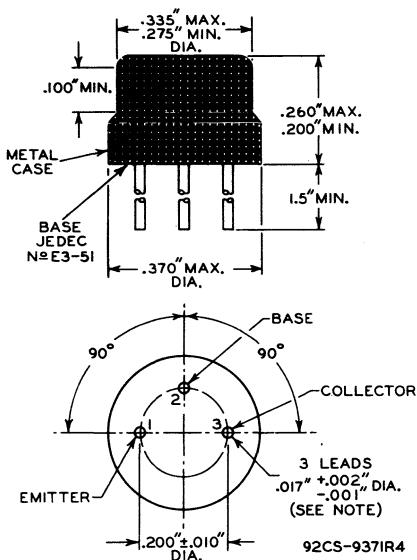
▲ Input resistance and capacitance with probe: 10 megohms shunted by 15 μ f.



2N1091

JUNCTION TRANSISTOR

2N1091



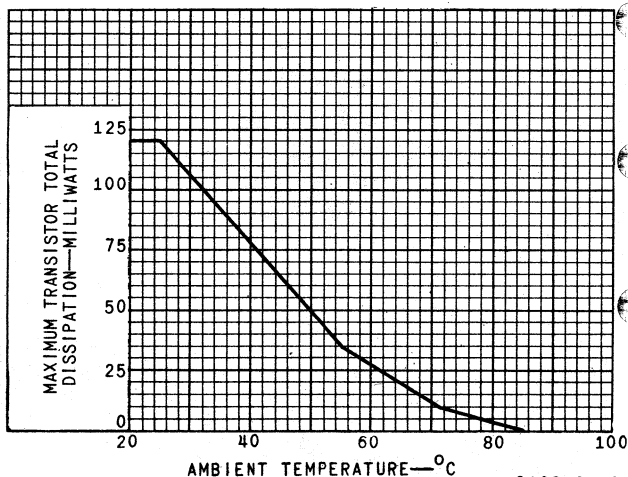
NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.050''$ AND $0.250''$ FROM THE BASE SEAT. BETWEEN $0.250''$ AND $1.50''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

2N1091



2N1091

RATING CHART



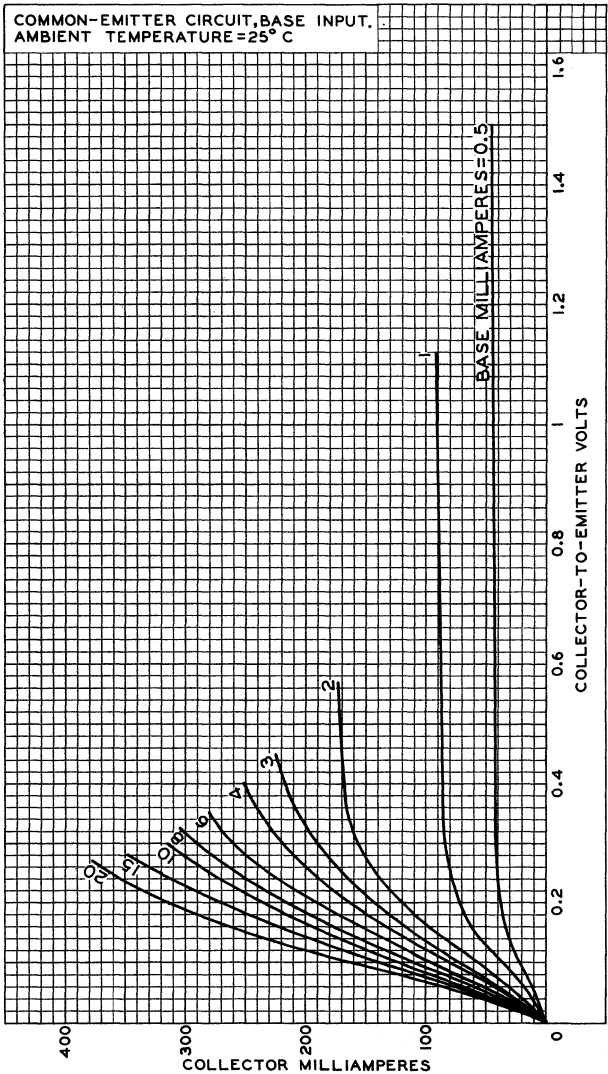


2N1091

2N1091

TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE = 25° C

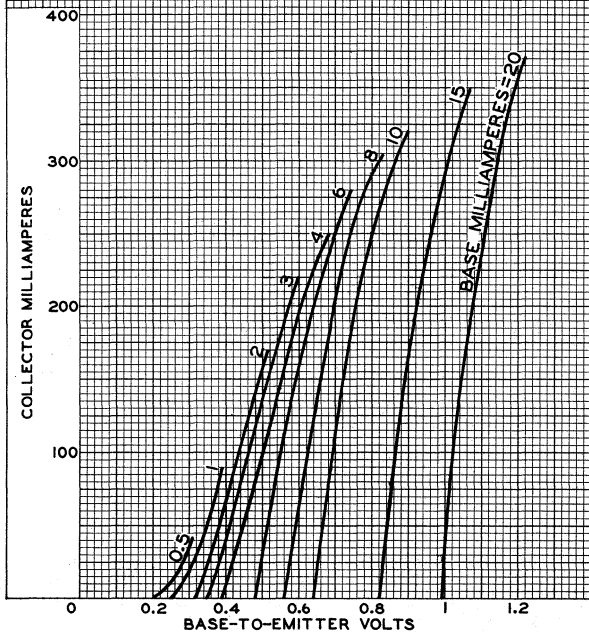


2N1091



2N1091

TYPICAL TRANSFER CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE = 25° C

Power Transistor

GERMANIUM P-N-P ALLOY TYPE

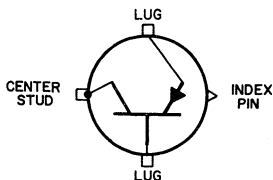
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Seated Length	0.520"
Maximum Diameter.	1.250"
Dimensional Outline	JEDEC No. TO-36
Case.	Welded, Metal
Seals	Hermetic
Terminal Diagram (See <i>Dimensional Outline</i>):	

BOTTOM VIEW



INDUSTRIAL SERVICE

*Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and audio
amplifier, relay- and solenoid-actuating circuits*

Maximum and Minimum Ratings, Absolute Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter-to-base reverse biased

(DC emitter-to-base volts = -1.5)	-80 max.	volts
EMITTER-TO-BASE VOLTAGE	-40 max.	volts
COLLECTOR CURRENT	-15 max.	amp
EMITTER CURRENT	15 max.	amp
BASE CURRENT.	-4 max.	amp

TRANSISTOR DISSIPATION:^a

At case temperatures^b of 25° C or below 150 max. watts

CASE-TEMPERATURE^b RANGE:

Operating and storage -65 to +100 °C

Typical Operation:

*In a common emitter, base-input, power-switching
circuit at case temperature^b of 25° C*

DC Supply Voltage	-12	volts
DC Base-Bias Voltage.	6	volts
"On" DC Collector Current	-12	amp
"Turn-On" Base Current.	-2	amp
"Turn-Off" Base Current	0	amp

← Indicates a change.



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Semiconductor & Materials Division
Somerville, N. J.

DATA 1
8-61

Switching Time:

Rise time.	15	μ sec
Fall time.	15	μ sec

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

^b Measured at any point on seating surface.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25°C unless otherwise specified
Min. Typical Max.

DC Collector-to-Emitter

Breakdown Voltage:

With base connected to emitter, dc collector amperes =

-0.3 BV_{CES} -70 - - - volts

With base open:

For dc collector amperes = -0.3 . . . BV_{CEO} - - -60 - - - volts

For dc collector amperes = -1^c . . . -55 - - - volts

DC Base-to-Emitter

Voltage for dc collector-to-emitter volts = -2, dc collector amperes = -5. . .

V_{BE} - - -0.65 -0.9 volt

DC Collector-to-Emitter

Saturation Voltage

for dc collector amperes = -12, dc base amperes = -2

$V_{CE(sat)}$ - - -0.3 -0.7 volt

DC Emitter Voltage for

dc collector volts =

-80, dc emitter current = 0. V_{EB} - - -0.15 -1 volt

DC Punch-Through

Voltage. V_{PT} -80 - - - volts

DC Emitter-Cutoff

Current for dc emitter volts = -40, dc collector current = 0 . . .

I_{EBO} - - -1 -4 ma

DC Collector-Cutoff

Current:

With dc collector volts = -2, dc emitter current

= 0. I_{CBO} - 100 - μ a

With dc collector volts = -80, dc emitter current

= 0. -2 -4 ma

→ Indicates a change.



With dc collector volts = -80, dc emitter current = 0, case temperature ^b = 71° C.					-	-	-15	ma
DC Current Transfer Ratio for dc col- lector-to-emitter volts = -2, dc collector amperes =					h_{FE}			
-5					35	-	70	
-12					-	25	-	
Beta-Cutoff Frequency for dc collector-to- emitter volts = -6, dc collector amperes = -5					f_{ae}	-	10	kc
Thermal Resistance: Junction-to-case . . .					R_T	-	0.35	°C/watt
Thermal Capacity for pulse duration of 1 to 10 milliseconds. . . .						-	0.075	watt- sec/°C
Thermal Time Constant. .					τ_1	-	26.25	msec

^b Measured at any point on seating surface.

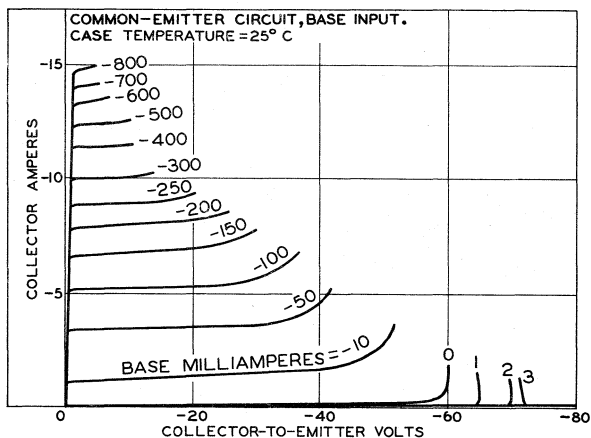
^c Tested by sweep method to prevent excessive heating of collector junction.

PERFORMANCE TESTS,
 OPERATING CONSIDERATIONS,
 DIMENSIONAL OUTLINE,
 SUGGESTED MOUNTING ARRANGEMENT,
 RATING CHART,
 TYPICAL BASE-CHARACTERISTICS CURVES,
 and
 TYPICAL CHARACTERISTICS CURVES
 shown under Type 2N173 also apply to the 2N1099

← Indicates a change.



TYPICAL COLLECTOR CHARACTERISTICS



92CS-10733



Power Transistor

GERMANIUM P-N-P ALLOY TYPE

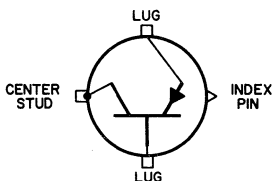
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Seated Length	0.520"
Maximum Diameter.	1.250"
Dimensional Outline	JEDEC No. TO-36
Case.	Welded, Metal
Seals	Hermetic
Terminal Diagram (See <i>Dimensional Outline</i>):	

BOTTOM VIEW



INDUSTRIAL SERVICE

*Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and audio-
amplifier, relay- and solenoid-actuating circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter-to-base reverse biased

(DC emitter-to-base volts = -1.5)

-100 max. volts

EMITTER-TO-BASE VOLTAGE -80 max. volts

COLLECTOR CURRENT -15 max. amp

EMITTER CURRENT 15 max. amp

BASE CURRENT. -4 max. amp

TRANSISTOR DISSIPATION:^a

At case temperatures^b of 25° C or below. 150 max. watts

CASE-TEMPERATURE^b RANGE:

Operating and storage -65 to +100 °C

Typical Operation:

*In a common-emitter, base-input, power-switching
circuit at case temperature^b of 25° C*

DC Supply Voltage -12 volts

DC Base-Bias Voltage. 6 volts

"On" DC Collector Current -12 amp

"Turn-On" Base Current. -2 amp

"Turn-Off" Base Current 0 amp

← Indicates a change.



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DATA 1
8-61

2N1100

Switching Time:

Rise time	15	μ sec
Fall time	15	μ sec

^a See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

^b Measured at any point on seating surface.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25° C unless otherwise specified

Min. Typical Max.

DC Collector-to-Emitter

Breakdown Voltage:

With base connected to emitter, dc collector

amperes = -0.3. BV_{CES} -80 - - volts

With base open:

For dc collector

amperes = -1^c. BV_{CEO} -65 - - volts

DC Base-to-Emitter

Voltage for dc collector-to-emitter volts

= -2, dc collector

amperes = -5. V_{BE} - -0.65 -0.9 volt

DC Collector-to-Emitter

Saturation Voltage for dc collector amperes =

-12, dc base amperes = -2.

$V_{CE(sat)}$ - -0.3 -0.7 volt

DC Emitter Voltage for

dc collector volts =

-100, dc emitter

current = 0. V_{EB} - - -1 volt

DC Punch-Through Voltage .

V_{PT} -100 - - volts

DC Emitter-Cutoff Current

for dc emitter volts

= -80, dc collector

current = 0. I_{EBO} - -1 -4 ma

DC Collector-Cutoff

Current: I_{CBO}

With dc collector volts

= -2, dc emitter

current = 0. - 100 - μ a

With dc collector volts

= -100, dc emitter

current = 0. - -2 -4 ma

With dc collector volts

= -100, dc emitter

current = 0, case temperature^b = 71° C. - - -15 ma

→ Indicates a change.



DC Current Transfer Ratio for dc collector-to-emitter volts = -2, dc collector amperes =	h_{FE}			
-5.	25	-	50	
-12.	-	20	-	
Beta-Cutoff Frequency for dc collector-to-emitter volts = -6, dc collector amperes = -5.	f_{ae}	10	-	kc
Thermal Resistance: Junction-to-case.	R_T	0.35	0.5	$^{\circ}\text{C}/\text{watt}$
Thermal Capacity for pulse duration of 1 to 10 milliseconds.		0.075	-	watt-sec/ $^{\circ}\text{C}$
Thermal Time Constant	τ_1	26.25	-	msec

^b Measured at any point on seating surface.

^c Tested by sweep method to prevent excessive heating of collector junction.

PERFORMANCE TESTS

This transistor type is designed to pass the environmental tests specified in Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connection can be made to the base and emitter lugs by means of clips or by soldering directly to the lugs. When soldering connections are made to the lugs, care should be taken to conduct excessive heat away from the lug seals, otherwise the heat of the soldering operation will crack the glass seals of the lugs and damage the transistor.

This transistor is provided with a single-ended stud for mounting to a heat sink and for electrical connection to the collector. (See accompanying *Suggested Mounting Arrangement*). Electrical connection to the base and to the emitter is made to their respective lugs.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

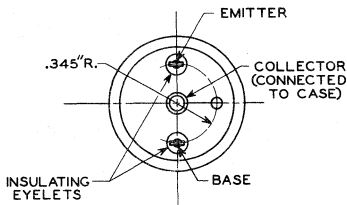
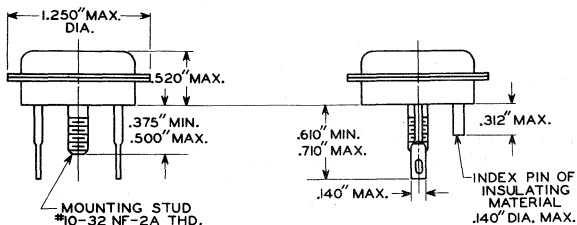
The maximum torque on mounting stud should not exceed 12 inch-pounds.

← indicates a change.



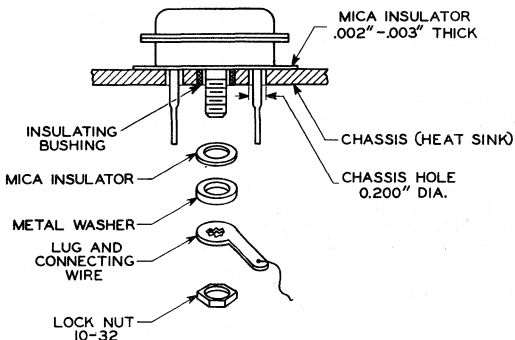
2N1100

JEDEC No. T0-36



92CM-10612RI

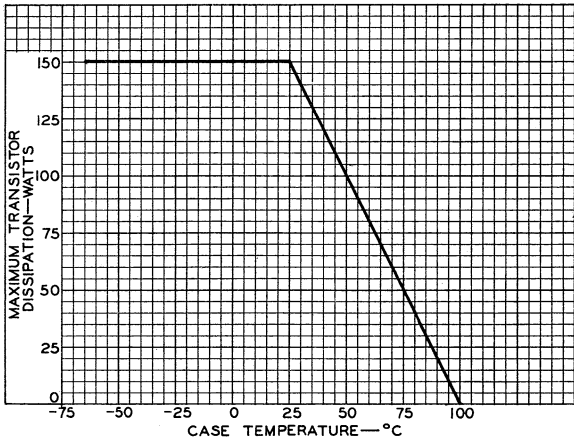
SUGGESTED MOUNTING ARRANGEMENT



92CS-10624RI

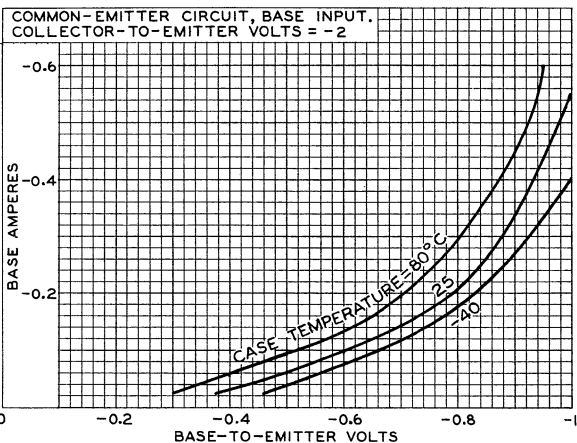


RATING CHART



92CS-10702RI

TYPICAL BASE CHARACTERISTICS



92CS-10706

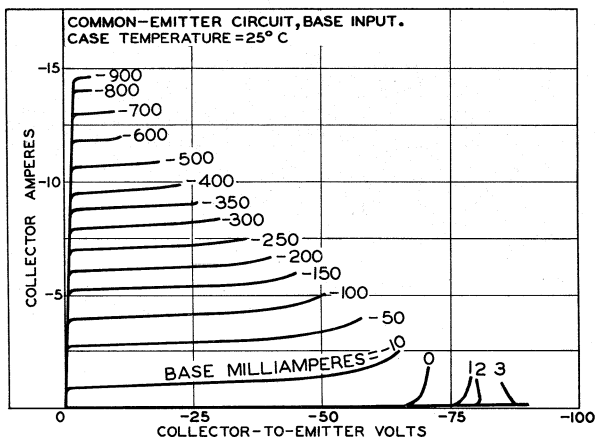


RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

DATA 3
8-61

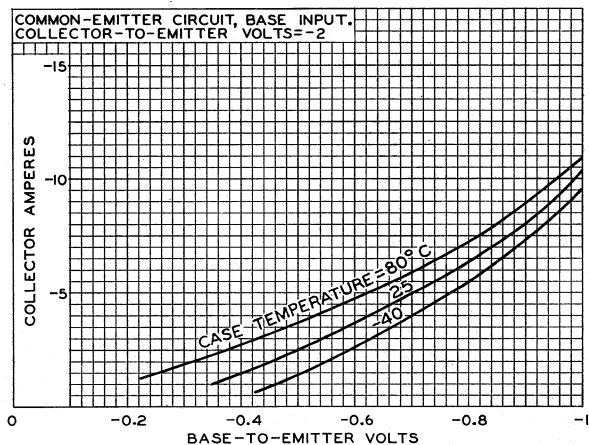
2N1100

TYPICAL COLLECTOR CHARACTERISTICS



92CS-10724

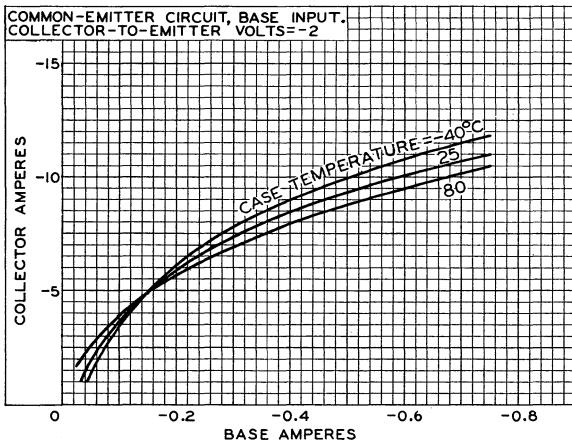
TYPICAL CHARACTERISTICS



92CS-10710



TYPICAL CHARACTERISTICS



92CS-10711



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Radio-Frequency-Amplifier Applications in FM and AM/FM Radio Receivers

GENERAL DATA

Electrical, At Ambient Temperature of 25° C:

Minimum DC Collector-to-Base

Breakdown Voltage for dc emitter-to-base volts = -0.5, dc collector

$\mu\text{a} = -50$ -30 volts

Maximum DC Collector-Cutoff

Current (I_{CBO}) for dc collector-

to-base volts = -12, emitter open. -12 μa

Maximum DC Emitter-Cutoff

Current (I_{EBO}) for dc emitter-

to-base volts = -1, collector open -12 μa

Mechanical:

Operating Position Any

Maximum Overall Length 0.577"

Maximum Seated Length. 0.375"

Maximum Diameter 0.360"

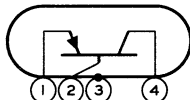
Dimensional Outline. JEDEC No. TO-45

Case Metal

Seals. Hermetic

Terminal Diagram:

Pin 1 - Emitter



Pin 3 - Interpin
Shield,
Case

Pin 2 - Base

Pin 4 - Collector

RADIO-FREQUENCY AMPLIFIER

Maximum and Minimum Ratings, Absolute-Maximum Values:

DC COLLECTOR-TO-BASE VOLTAGE -30 max. volts

DC EMITTER-TO-BASE VOLTAGE -1 max. volt

DC COLLECTOR CURRENT -10 max. ma

DC EMITTER CURRENT 10 max. ma

TRANSISTOR DISSIPATION:

At ambient temperature of 25° C. 80 max. mw

At ambient temperature of 55° C. 50 max. mw

At ambient temperature of 71° C. 23 max. mw

AMBIENT TEMPERATURE (During operation) 71 max. °C

STORAGE-TEMPERATURE RANGE. -65 to +85 °C

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage. -12 volts

DC Collector Current -1 ma

Current Transfer Ratio at 1 kc 100



Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-12	volts
DC Collector Current	-1	ma
Current Transfer Ratio at 1 kc	0.990	
Alpha-Cutoff Frequency	140	Mc

Typical Operation, At Ambient Temperature of 25° C:

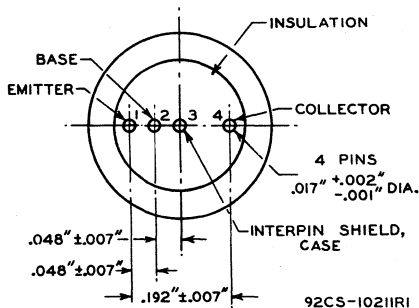
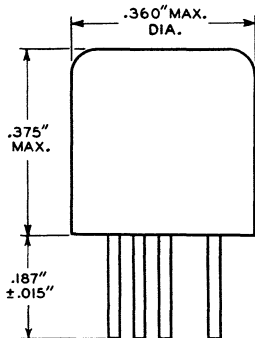
Common-Base Circuit, Emitter Input at a signal frequency of 100 Mc

DC Collector-to-Base Voltage	-12	volts
DC Emitter Current	1.5	ma
Input Resistance, ac output circuit shorted . .	45	ohms
Output Resistance, ac input circuit shorted . .	3800	ohms
Extrinsic Transconductance	24250	μ hos
Collector-to-Base Output Capacitance (C_{ob}) . .	2	μ f
Maximum Available Power Gain	14	db

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

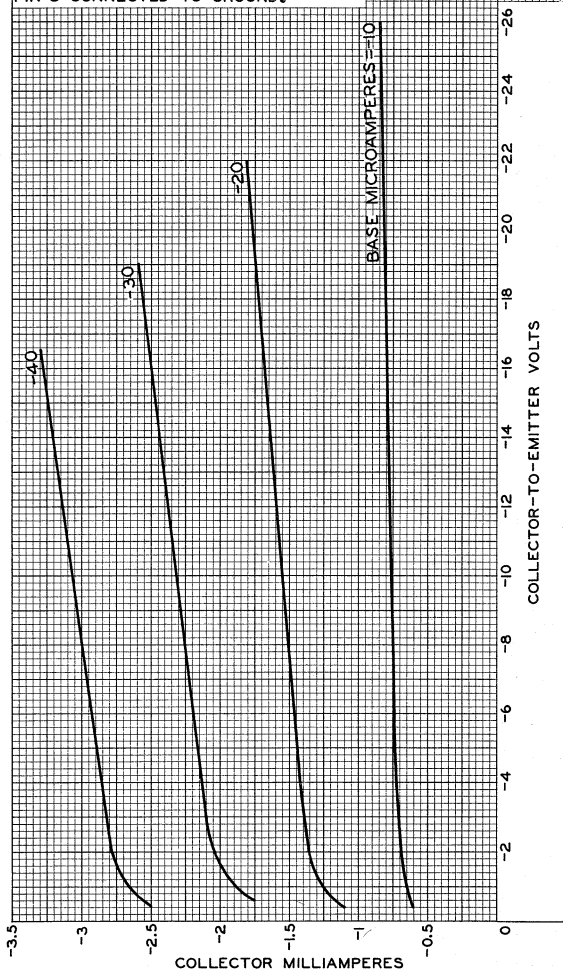
This transistor utilizes shielding to minimize interpin capacitance and coupling to adjacent circuit components. This shielding is provided to pin 3 situated between the collector pin and the base pin and internally connected to the case. For optimum performance, it is recommended that pin 3 be connected to the chassis ground.



2N1177

AVERAGE COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE = 25°C
PIN 3 CONNECTED TO GROUND.

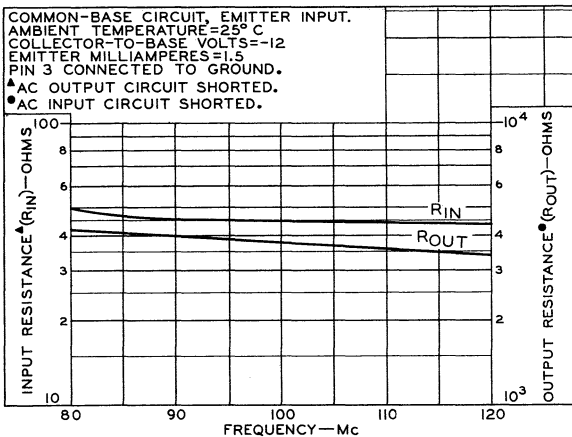


92CM-10200RI

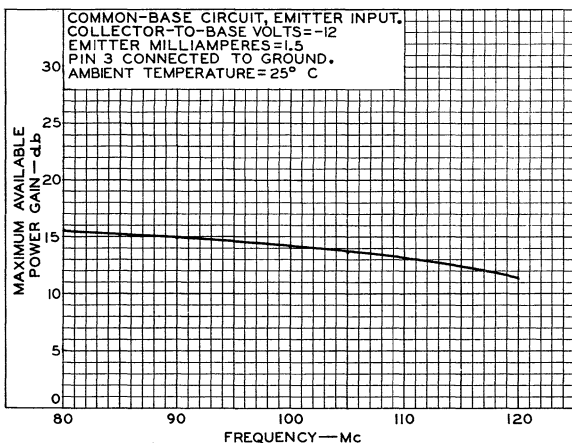
RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.



PERFORMANCE CHARACTERISTICS



92CS-10201



92CS-10205



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Radio-Frequency-Oscillator Applications in FM and AM/FM Radio Receivers

GENERAL DATA

Electrical, At Ambient Temperature of 25° C:

Minimum DC Collector-to-Base

Breakdown Voltage for

dc emitter-to-base volts = -0.5,

dc collector μ a = -50. -30 volts

Maximum DC Collector-Cutoff

Current (I_{CBO}) for dc collector-

to-base volts = -12, emitter open. -12 μ a

Maximum DC Emitter-Cutoff

Current (I_{EBO}) for dc emitter-

to-base volts = -1, collector open -12 μ a

Mechanical:

Operating Position Any

Maximum Overall Length 0.577"

Maximum Seated Length. 0.375"

Maximum Diameter 0.360"

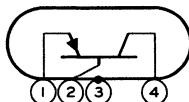
Dimensional Outline. JEDEC No. TO-45

Case Metal

Seals. Hermetic

Terminal Diagram:

Pin 1 - Emitter



Pin 2 - Base

Pin 3 - Interpin
Shield,
Case

Pin 4 - Collector

RADIO-FREQUENCY OSCILLATOR

Maximum and Minimum Ratings, Absolute-Maximum Values:

DC COLLECTOR-TO-BASE VOLTAGE -30 max. volts

DC EMITTER-TO-BASE VOLTAGE -1 max. volt

DC COLLECTOR CURRENT -10 max. ma

DC EMITTER CURRENT 10 max. ma

TRANSISTOR DISSIPATION:

At ambient temperature of 25° C. 80 max. mW

At ambient temperature of 55° C. 50 max. mW

At ambient temperature of 71° C. 23 max. mW

AMBIENT TEMPERATURE (During operation) 71 max. °C

STORAGE-TEMPERATURE RANGE. -65 to +85 °C

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage. -12 volts

DC Collector Current -1 ma

Current Transfer Ratio at 1 kc 40



2N1178

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage.	-12	volts
DC Collector Current.	-1	ma
Current Transfer Ratio at 1 kc.	0.976	
Alpha-Cutoff Frequency.	140	Mc

Typical Operation, At Ambient Temperature of 25° C:

Common-Base Circuit, Emitter Input at a frequency of 110.7 Mc

DC Collector-to-Base Voltage.	-11	volts
DC Emitter Current.	2.5	ma
Extrinsic Transconductance.	21800	μ mhos
Collector-to-Base Output.		
Capacitance (C_{ob})	2	μ f

OPERATING CONSIDERATIONS, DIMENSIONAL OUTLINE, and CURVES

shown under Type 2N1177 also apply to the 2N1178



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Radio-Frequency-Mixer Applications
in FM and AM/FM Radio Receivers

GENERAL DATA

Electrical, At Ambient Temperature of 25° C:

Minimum DC Collector-to-Base

Breakdown Voltage for

dc emitter-to-base volts = -0.5,

dc collector μ a = -50. -30 volts

Maximum DC Collector-Cutoff

Current (I_{CBO}) for dc collector-

to-base volts = -12, emitter open. -12 μ a

Maximum DC Emitter-Cutoff

Current (I_{EBO}) for dc emitter-

to-base volts = -1, collector open -12 μ a

Mechanical:

Operating Position Any

Maximum Overall Length 0.577"

Maximum Seated Length. 0.375"

Maximum Diameter 0.360"

Dimensional Outline. JEDEC No. TO-45

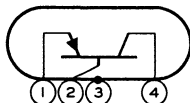
Case Metal

Seals. Hermetic

Terminal Diagram:

Pin 1-Emitter

Pin 2-Base



Pin 3- Interpin
Shield,
Case

Pin 4-Collector

RADIO-FREQUENCY MIXER

Maximum and Minimum Ratings, Absolute-Maximum Values:

DC COLLECTOR-TO-BASE VOLTAGE -30 max. volts

DC EMITTER-TO-BASE VOLTAGE -1 max. volt

DC COLLECTOR CURRENT -10 max. ma

DC EMITTER CURRENT 10 max. ma

TRANSISTOR DISSIPATION:

At ambient temperature of 25° C. 80 max. mw

At ambient temperature of 55° C. 50 max. mw

At ambient temperature of 71° C. 23 max. mw

AMBIENT TEMPERATURE (During operation) 71 max. °C

STORAGE-TEMPERATURE RANGE. -65 to +85 °C

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage. -12 volts

DC Collector Current -1 volt

Current Transfer Ratio at 1 kc 80



Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage.	-12	volts
DC Collector Current.	-1	volt
Current Transfer Ratio at 1 kc.	0.988	
Alpha-Cutoff Frequency.	140	Mc

Typical Operation, At Ambient Temperature of 25° C:

Common-Base Circuit, Emitter Input at a signal frequency of 100 Mc

DC Collector-to-Base Voltage.	-12	volts
DC Emitter Current.	0.8	ma
Input Resistance, ac output circuit shorted	40	ohms
Output Resistance, ac input circuit shorted, at a intermediate frequency of 10.7 Mc.	90000	ohms
RMS Base-to-Emitter Oscillator Injection Voltage	125	mv
Extrinsic Conversion Transconductance	7500	μ mhos
Collector-to-Base Output Capacitance (C_{ob}).	2	$\mu\mu$ f
Maximum Available Conversion Power Gain.	17	db

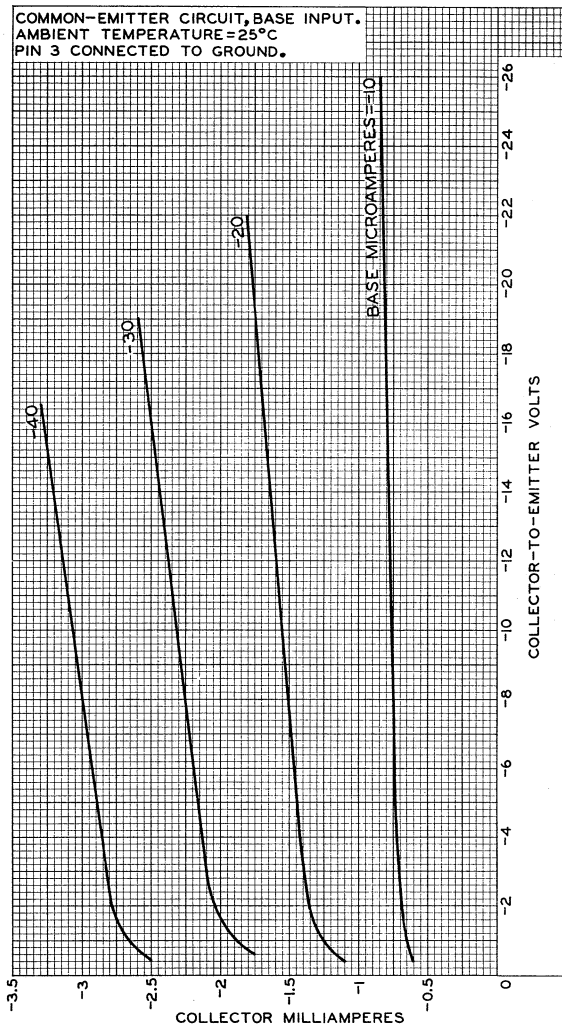
OPERATING CONSIDERATIONS and DIMENSIONAL OUTLINE

shown under Type 2N1177 also apply to the 2N1179



AVERAGE COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE = 25°C
PIN 3 CONNECTED TO GROUND.



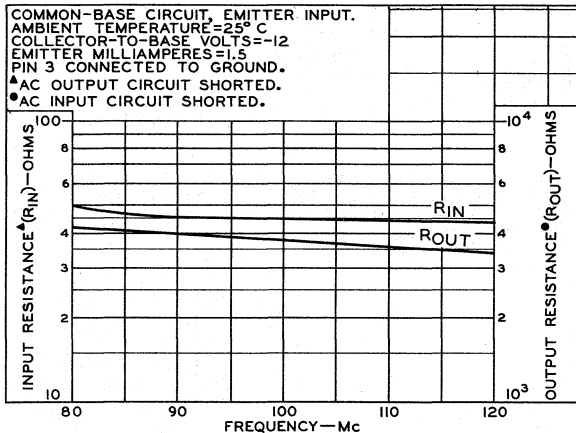
92CM-10200RI



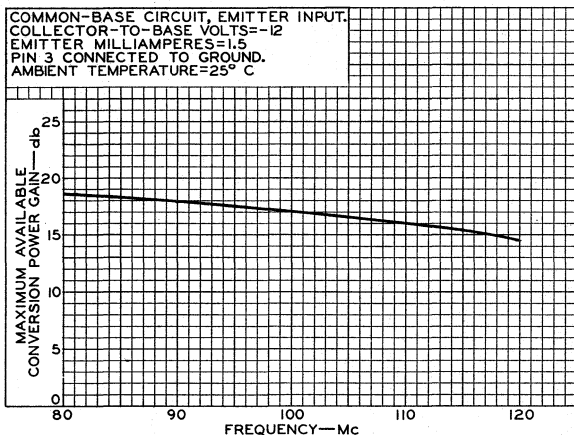
RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

DATA 2
3-60

PERFORMANCE CHARACTERISTICS



92CS-10201



92CS-10204



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Intermediate-Frequency-Amplifier Applications in FM and AM/FM Radio Receivers

GENERAL DATA

Electrical, At Ambient Temperature of 25° C:

Minimum DC Collector-to-Base

Breakdown Voltage for

dc emitter-to-base volts = -0.5,

dc collector μ a = -50. -30 volts

Maximum DC Collector-Cutoff

Current (I_{CBO}) for dc collector-to-base volts = -12, emitter open. -12 μ a

Maximum DC Emitter-Cutoff

Current (I_{EBO}) for dc emitter-to-base volts = -0.5, collector open -12 μ a**Mechanical:**

Operating Position Any

Maximum Overall Length 0.577"

Maximum Seated Length. 0.375"

Maximum Diameter 0.360"

Dimensional Outline. JEDEC No. TO-45

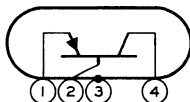
Case Metal

Seals. Hermetic

Terminal Diagram:

Pin 1-Emitter

Pin 2-Base

Pin 3-Interpin
Shield,
Case

Pin 4-Collector

INTERMEDIATE-FREQUENCY AMPLIFIER

Maximum and Minimum Ratings, Absolute-Maximum Values:

DC COLLECTOR-TO-BASE VOLTAGE -30 max. volts

DC EMITTER-TO-BASE VOLTAGE -0.5 max. volt

DC COLLECTOR CURRENT -10 max. ma

DC EMITTER CURRENT 10 max. ma

TRANSISTOR DISSIPATION:

At ambient temperature of 25° C. 80 max. mw

At ambient temperature of 55° C. 50 max. mw

At ambient temperature of 71° C. 23 max. mw

AMBIENT TEMPERATURE (During operation) 71 max. °C

STORAGE-TEMPERATURE RANGE. -65 to +85 °C

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage. -12 volts

DC Collector Current -1 ma

Current Transfer Ratio at 1 kc 80



2N1180

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage.	-12	volts
DC Collector Current.	-1	ma
Current Transfer Ratio at 1 kc.	0.988	
Alpha-Cutoff Frequency.	100	Mc

Typical Operation, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input at a frequency of 10.7 Mc

DC Collector-to-Emitter Voltage	-12	volts
DC Emitter Current.	1.5	ma
Input Resistance, ac output circuit shorted	325	ohms
Output Resistance, ac input circuit shorted	24000	ohms
Extrinsic Transconductance.	40250	μ mhos
Collector-to-Base Output Capacitance (C_{ob})	2	μ f
Maximum Power Gain:		

	Single Stage	Three Stages	
Available	35	35	db
Useful:			
In neutralized circuit.	23	21.6	db
In unneutralized circuit.	20	19	db

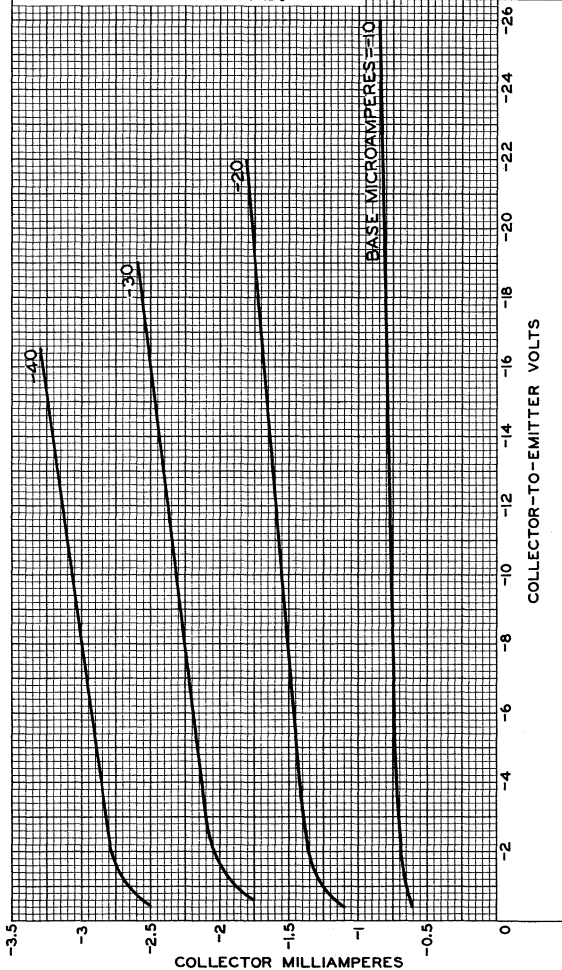
OPERATING CONSIDERATIONS and DIMENSIONAL OUTLINE

shown under Type 2N1177 also apply to the 2N1180



AVERAGE COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE = 25°C
PIN 3 CONNECTED TO GROUND.



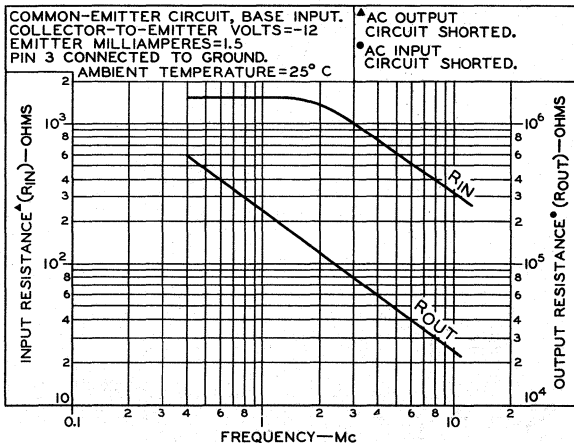
92CM-10200RI



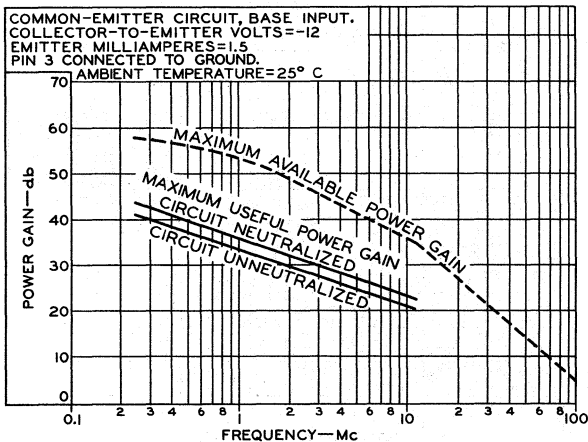
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Semiconductor & Materials Division
Somerville, N. J.

DATA 2
3-60

PERFORMANCE CHARACTERISTICS



92CS-10202



92CS-10203RI



2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B

Power Transistors

GERMANIUM P-N-P ALLOY TYPE

For Intermediate-Power Switching and Amplifier
Service in Industrial and Military Applications

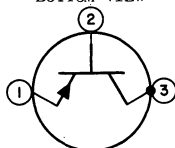
Mechanical:

Dimensions. See Outline TO-8 in General Section

Terminal Diagram:

BOTTOM VIEW

Pin 1 - Emitter
Pin 2 - Base



Pin 3 - Collector,
Case

INDUSTRIAL SERVICE

*Such as in dc-to-dc converter, multivibrator
voltage-regulator, and dc-amplifier circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

	2N1183 2N1184	2N1183A 2N1184A	2N1183B 2N1184B	
Collector-to-Base Voltage V_{CBO}	-45	-60	-80	volts
Collector-to-Emitter Voltage Base-to-emitter volts = 1.2 . . . V_{CEV}	-45	-60	-80	volts
With base connected to emitter. . . . V_{CES}	-35	-50	-60	volts
With base open. . . V_{CEO}	-20	-30	-40	volts
Emitter-to-Base Voltage V_{EBO}	-20	-20	-20	volts
Collector Current . . . I_C	-3	-3	-3	amp
Emitter Current I_E	3.5	3.5	3.5	amp
Base Current. I_B	-0.5	-0.5	-0.5	amp

The Following Values Apply to all 6 Types

Transistor Dissipation

At case temperature^a for
operation with heat sink

From -65° to 25°C. . . P_T 7.5 watts

Above 25°C. Derate linearly 0.100 watt/°C

At free-air temperatures

From -65° to 25°C. . . P_T 1 watt

Above 25°C. Derate linearly 0.013 watt/°C

Free-Air Temperature Range

Operating T_{opr} -65 to 100 °C

Storage T_{stg} -65 to 100 °C



RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Harrison, N. J.

DATA 1
2-65

2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode-voltage and electrode-current values for given test conditions are dc at case temperature with heat sink = 25°C.

	2N1183 2N1184	2N1183A 2N1184A	2N1183B 2N1184B	
Collector-to-Emitter Voltage				
$I_C = -250$ ma, $V_{BE} = 1.2$ volts.	V_{CEV} -45	-60	-80	min. volts
$I_C = -50$ ma	V_{CES} -35	-50	-60	min. volts
$I_C = -50$ ma	V_{CEO} -20	-30	-40	min. volts
Collector-Cutoff Current				
$I_E = 0$, $V_{CB} = -1.5$ volts.	I_{CBO} -30	-30	-30	max. μ a
$V_{CB} = -45$ volts.	I_{CBO} -250	-	-	max. μ a
$V_{CB} = -60$ volts.	I_{CBO} -	-250	-	max. μ a
$V_{CB} = -80$ volts.	I_{CBO} -	-	-250	max. μ a
DC Forward-Current Transfer Ratio . . . h_{FE}				
$V_{CE} = -2$ volts, $I_C = -400$ ma	20	40		min.
	60	120		max.

The Following Values Apply to all 6 Types

Emitter-to-Base Voltage.	V_{EB}	1.5 max.	volts
$V_{CE} = -2$ volts, $I_C = -400$ ma			
Emitter-Cutoff Current	I_{EBO}	-100 max.	μ a
$I_C = 0$, $V_{BE} = 20$ volts			
Alpha-Cutoff Frequency	f_{hfb}	500 min.	kc
$V_{CB} = -6$ volts, $I_E = 1$ ma			
Collector Saturation Resistance. . .	R_S	1.25 max.	ohms
$I_B = -40$ ma, $I_C = -400$ ma			
Thermal Resistance			
Junction-to-case	θ_{JC}	10 max.	°C/watt
Junction-to-free air	θ_{JFA}	75 max.	°C/watt

Typical Operation:

In accompanying typical power-switching circuit at case temperature of 25°C with heat sink

DC Supply Voltage (B_2)	-12	volts
DC Base-Bias Voltage (B_1)	12	volts
"On" DC Collector Current.	-400	ma
"Turn-On" Base Current (I_{B1})	-40	ma
"Turn-Off" Base Current (I_{B2})	40	ma
Generator Resistance	50	ohms



2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B

Switching Time:

Delay time (t_d)	0.2	μsec
Rise time (t_r)	2	μsec
Storage time (t_s)	1.8	μsec
Fall time (t_f)	1.4	μsec

^a Case temperature is measured at center of bottom of case.

OPERATING CONSIDERATIONS

Under no circumstances should the case be soldered to the heat sink because the heat of the soldering operation will permanently damage the transistor.

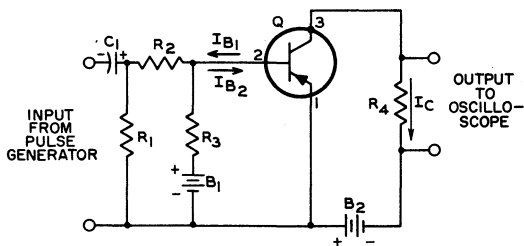
It is important that this transistor be securely fastened to a heat sink. A mounting clamp is provided for this purpose.

To prevent damage to the transistor by thermal runaway an external resistance may be placed in the emitter or collector circuit. The minimum value of this resistance may be obtained from the following equation:

$$R_{\min.} = \frac{E^2}{4 \left(P_o + \frac{25}{K} \right)}$$

E = DC collector supply voltage (volts)
 P_o = Collector-to-emitter voltage x collector current at desired operating point (watts)
 K = Thermal resistance--transistor and heat sink ($^{\circ}\text{C}/\text{watt}$)

TYPICAL POWER-SWITCHING CIRCUIT



$B_1, B_2 = 12 \text{ volts}$

$C_1 = 10 \mu\text{f}$, 25 volts, electrolytic

$Q = 2N1183, 2N1183A, 2N1183B, 2N1184, 2N1184A, \text{ or } 2N1184B$

$R_1 = 51 \text{ ohms}$, 2 watts

$R_2 = 120 \text{ ohms}$, 2 watts

$R_3 = 230 \text{ ohms}$, 1 watt

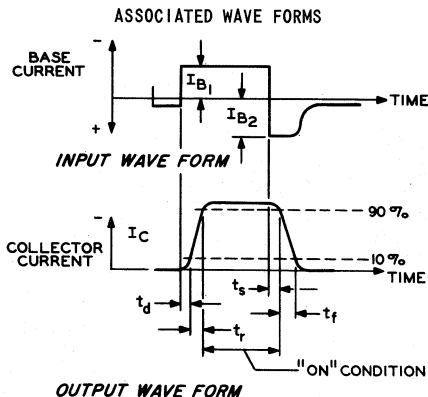
$R_4 = 29.5 \text{ ohms}$, 5 watts



RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Harrison, N. J.

DATA 2
2-65

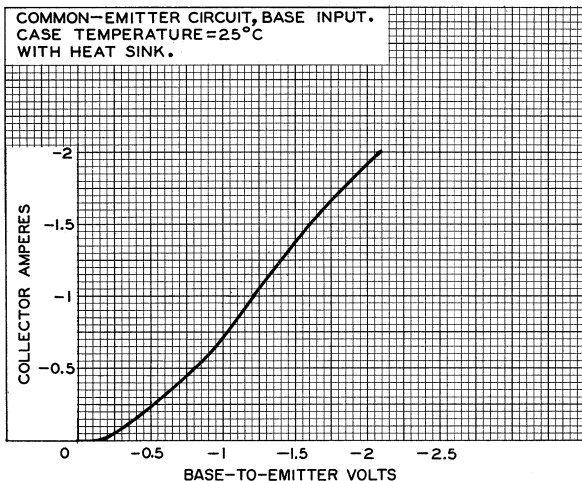
2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B



92CS-10459

Typical Transfer Characteristic

2N1183, 2N1183A, 2N1183B, 2N1184, 2N1184A, 2N1184B



92CS-10433R2

RADIO CORPORATION OF AMERICA
Electronic Components and Devices

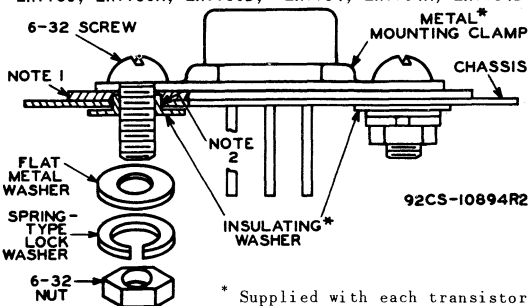
Harrison, N. J.



2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B

SUGGESTED MOUNTING ARRANGEMENT

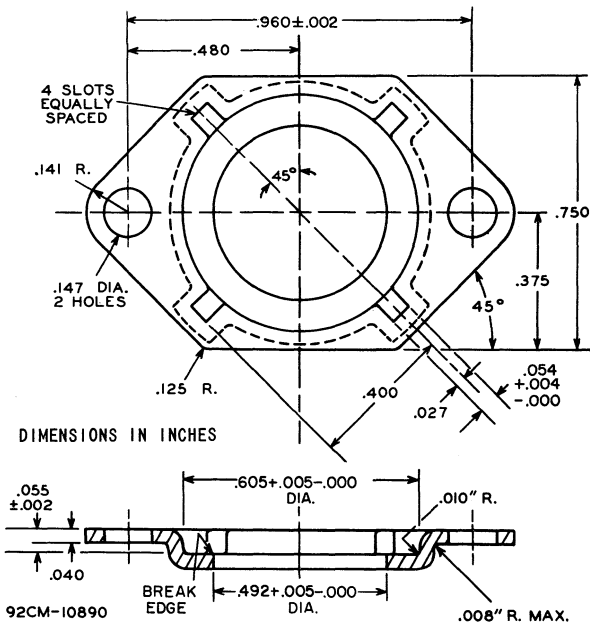
2N1183, 2N1183A, 2N1183B, 2N1184, 2N1184A, 2N1184B



NOTE 1: 0.002" mica insulator or anodized aluminum insulator* (drilled, or punched with burrs removed).

NOTE 2: Remove burrs from chassis holes.

MOUNTING CLAMP (Supplied with Each Transistor)



RADIO CORPORATION OF AMERICA
Electronic Components and Devices

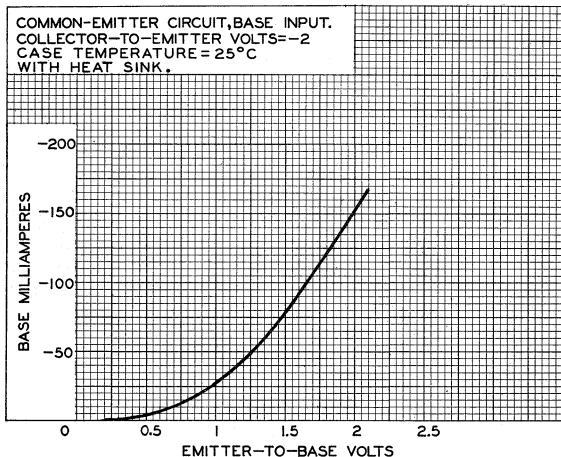
Harrison, N. J.

DATA 3
2-65

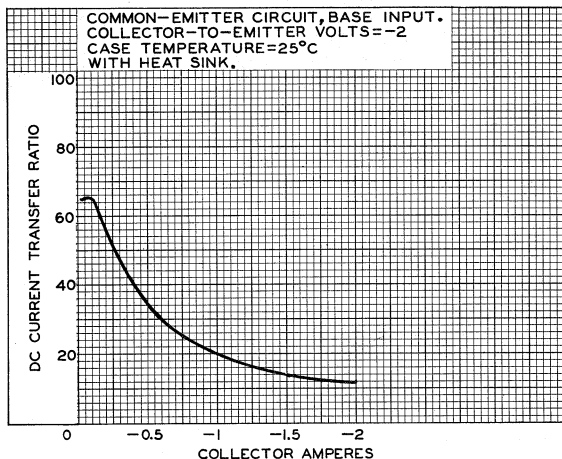
2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B

Typical Operation Characteristics

2N1183, 2N1183A, 2N1183B



92CS-10435RI



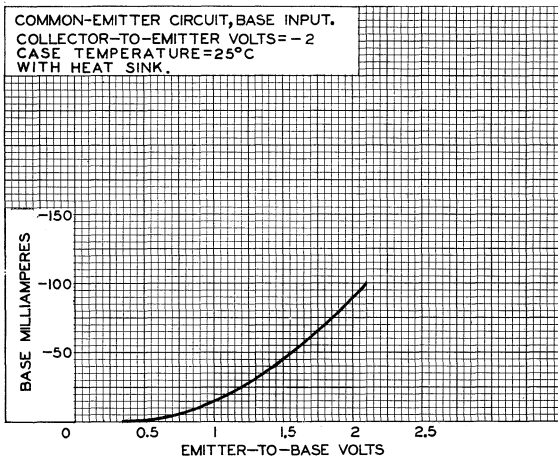
92CS-10431R2



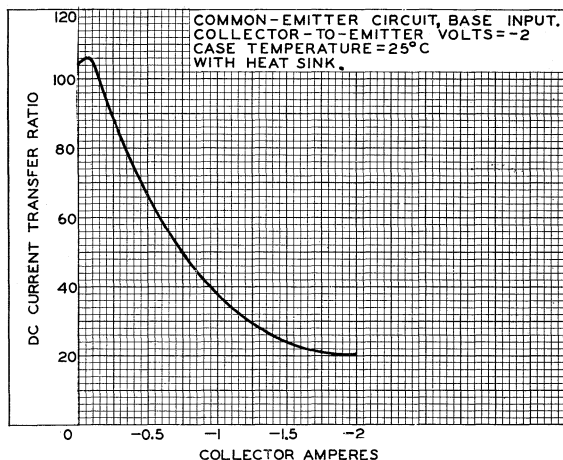
2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B

Typical Operation Characteristics

2N1184, 2N1184A, 2N1184B



92CS-10434R1



92CS-10432R2



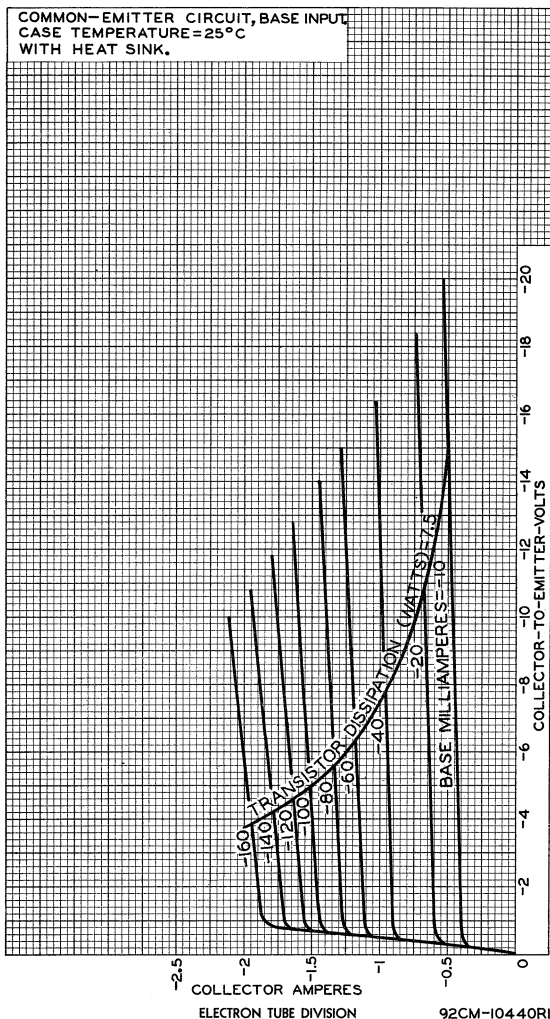
RADIO CORPORATION OF AMERICA
Electronic Components and Devices Harrison, N. J.

DATA 4
2-65

2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B

Typical Collector Characteristics

2N1183, 2N1183A, 2N1183B

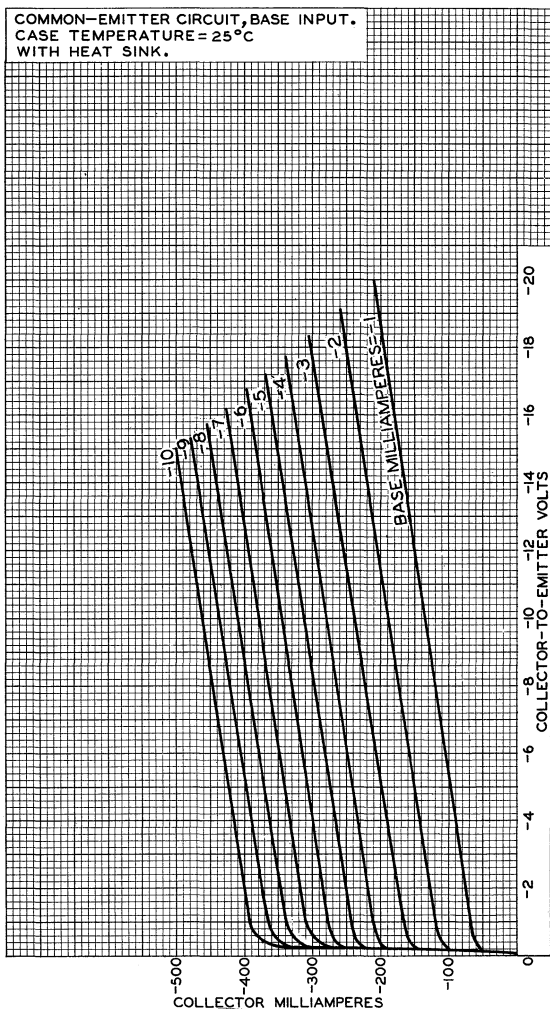


2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B

Typical Collector Characteristics

2N1183, 2N1183A, 2N1183B

COMMON-EMITTER CIRCUIT, BASE INPUT.
CASE TEMPERATURE = 25°C
WITH HEAT SINK.



92CM-10425R1



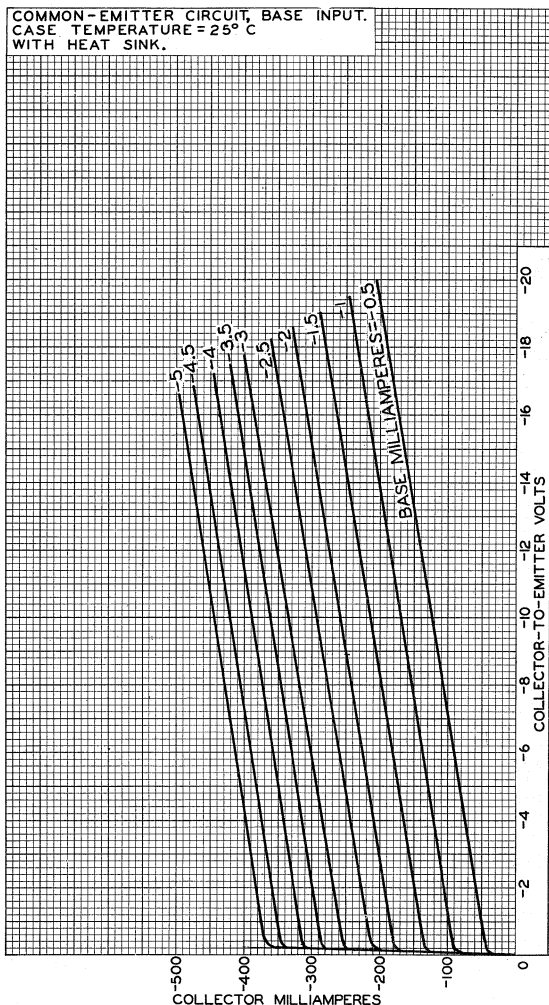
RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Harrison, N. J.

DATA 5
2-65

2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B

Typical Collector Characteristics 2N1184, 2N1184A, 2N1184B

COMMON-EMITTER CIRCUIT, BASE INPUT.
CASE TEMPERATURE = 25° C
WITH HEAT SINK.



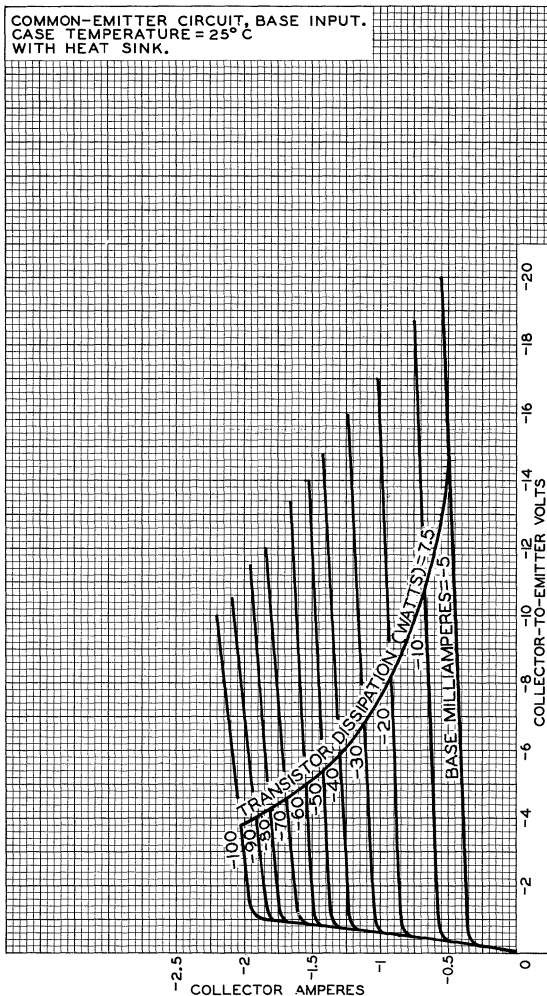
92CM-10426RI



2N1183, 2N1183A, 2N1183B 2N1184, 2N1184A, 2N1184B

Typical Collector Characteristics 2N1184, 2N1184A, 2N1184B

COMMON-EMITTER CIRCUIT, BASE INPUT.
CASE TEMPERATURE = 25°C
WITH HEAT SINK.

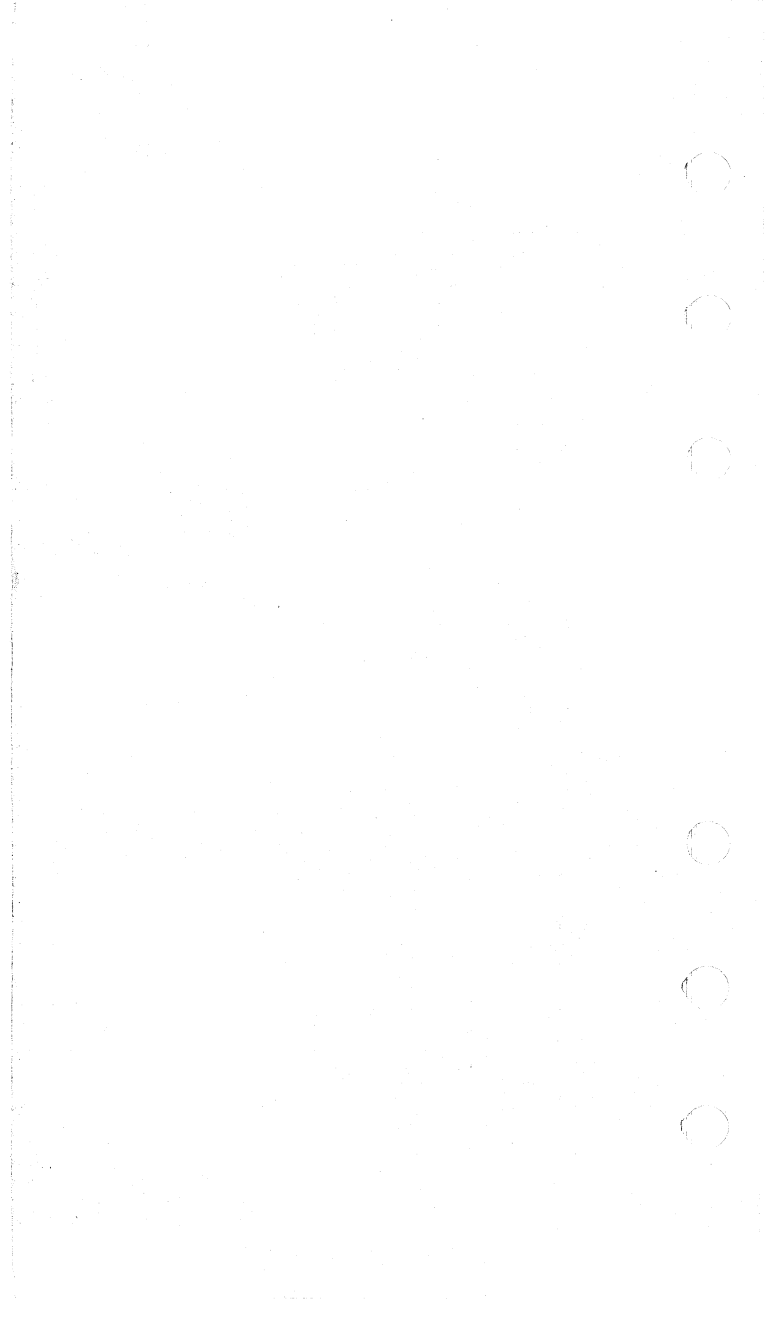


92CM-10439R1



RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Harrison, N. J.

DATA 6
2-65



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Industrial and Military Applications

The 2N1224 is the same as the 2N274 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads) 0.260"

Maximum Diameter. 0.370"

Dimensional Outline JEDEC No. TO-33

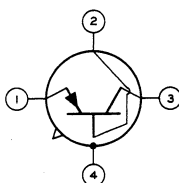
Terminal Diagram:

BOTTOM VIEW

Lead 1 - Emitter

Lead 3 - Collector

Lead 4 - Interlead
Shield,
Case



Lead 2 - Base

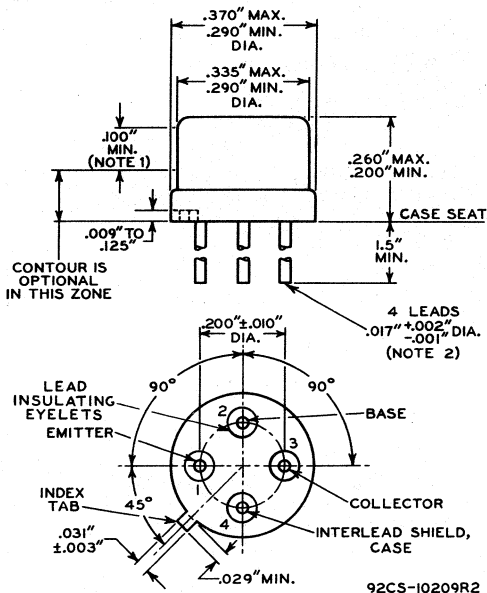
OPERATING CONSIDERATIONS

shown under Type 2N274 also apply to the 2N1224
with the addition of the following:

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar stand-off device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.



2N1224



NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE
For Industrial and Military Applications

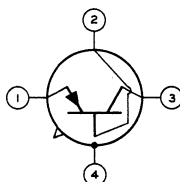
The 2N1225 is the same as the 2N384 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads) 0.260"
Maximum Diameter. 0.370"
Dimensional Outline JEDEC No. TO-33
Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector
Lead 4 - Interlead
Shield,
Case

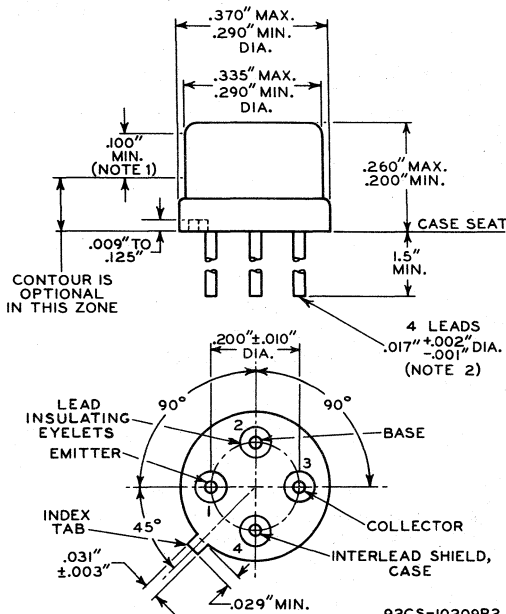
OPERATING CONSIDERATIONS

shown under Type 2N384 also apply to the 2N1225
with the addition of the following:

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.



2N1225



NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Industrial and Military Applications

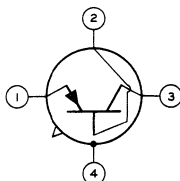
The 2N1226 is the same as the 2N274 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads) 0.260"
 Maximum Diameter 0.370"
 Dimensional Outline JEDEC No. TO-33
 Terminal Diagram: BOTTOM VIEW

Lead 1—Emitter

Lead 2—Base



Lead 3—Collector
 Lead 4—Interlead
 Shield,
 Case

INDUSTRIAL SERVICE**Maximum and Minimum Ratings, Absolute-Maximum Values:**

COLLECTOR-TO-BASE VOLTAGE (Emitter open) . . -60 max. volts
 COLLECTOR-TO-EMITTER VOLTAGE
 (Base-to-emitter volts = 0.5) -60 max. volts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base unless otherwise specified. Ambient temperature = 25° C.

	Typical Values	Range Values	
		Min.	Max.
DC Collector Breakdown Voltage (BV_{CBO}) with dc collector $\mu a = -50$, and dc emitter ma. = 0	-100	-60	-
Punch-Through Voltage (V_P) with dc emitter volts = -0.5.	-100	-60	-

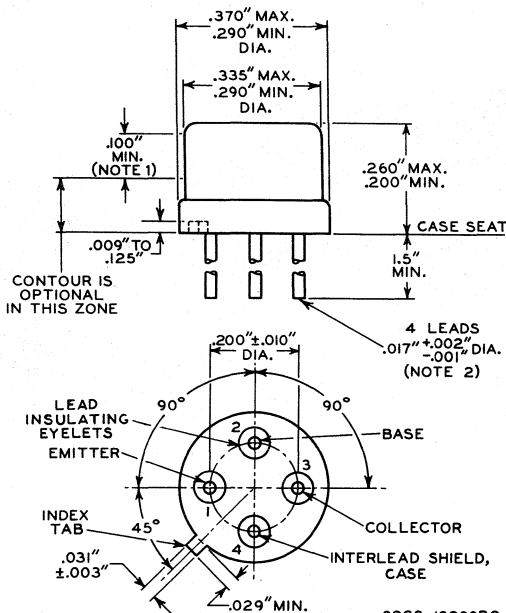
OPERATING CONSIDERATIONS

shown under Type 2N274 also apply to the 2N1226
 with the addition of the following:

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.



2N1226



NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

Mesa Transistor

GERMANIUM P-N-P DIFFUSED-JUNCTION TYPE
For High-Speed Switching Service in Commercial and Military Data-Processing Systems

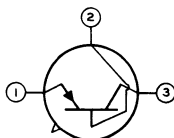
GENERAL DATA

Mechanical:

Operating Position	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter	0.370"
Dimensional Outline	JEDEC No. TO-5
Case	Welded, Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length	1.5"
Orientation and diameter	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	-13 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE	-12 max.	volts
EMITTER-TO-BASE VOLTAGE ^a	-1 max.	volt
COLLECTOR CURRENT	-100 max.	ma
EMITTER CURRENT	100 max.	ma

TRANSISTOR DISSIPATION:^b

At ambient temperature of 25° C	150 max.	mw
At ambient temperature of 55° C	75 max.	mw
At ambient temperature of 71° C	35 max.	mw

AMBIENT-TEMPERATURE RANGE:

Operating and storage	-65 to +85	°C
---------------------------------	------------	----

LEAD TEMPERATURE:

For immersion in molten solder		
for 10 seconds maximum	255 max.	°C

Typical Operation:

In an inverter circuit at
ambient temperature of 25° C

Collector-to-Emitter Voltage	-5	volts
Base Resistor	5000	ohms
Collector Resistor	500	ohms
"Turn-On" Base Voltage	-5	volts
"Turn-Off" Base Voltage	5	volts

← Indicates a change.



2N1300

"On" Collector Current.	-10	ma
"Turn-On" Base Current.	-0.66	ma
"Turn-Off" Base Current.	0.66	ma
Switching Time:		
Delay time (t_d)	0.14	μ sec
Rise time (t_r)	0.16	μ sec
Storage time (t_s)	0.14	μ sec
Fall time (t_f)	0.11	μ sec

^a This rating may be exceeded and the emitter-to-base junction operated in the breakdown condition provided the emitter dissipation is limited to 30 milliwatts at 25° C. For ambient temperatures above 25° C, the dissipation should be reduced by 0.5 milliwatt/°C.

^b See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base unless otherwise specified. Ambient temperature of 25° C.

Min. Typical Max.

DC Collector Breakdown				
Voltage for dc collector ma. = -0.02, emitter open.	BV_{CBO}	-13	-30	- volts
DC Collector-to-Emitter Breakdown Voltage	BV_{CERL}	-12	-25	- volts
DC Emitter Breakdown				
Voltage for dc emitter ma. = -0.1, collector open.	BV_{EBO}	-1	-3	- volts
DC Punch-Through Voltage. V_P		-12	-30	- volts
DC Base-to-Emitter				
Voltage for dc collector ma. = -40, dc base ma. = -1.	V_{BE}	-	-0.3	-0.4 volt
DC Collector-Cutoff				
Current for collector volts = -6, emitter open.	I_{CBO}	-	-1	-3 μ a
→ Collector Capacitance for dc collector volts = -6, emitter open.	C_C	-	8	12 μ f
DC Current Transfer Ratio for dc collector-to-emitter volts = -0.3, dc collector ma. = -10	h_{FE}	30	50	-
Gain-Bandwidth Product ^c for collector-to-emitter volts = -3, collector ma. = -10	GBW	25	40	- Mc

→ Indicates a change.



Thermal Resistance:

Junction-to-free air. . R_T - - 400 °C/watt

Total Stored Charge for

dc collector ma. = -10,

dc base ma. = -1. . . . Q_S - 250 400 $\mu\text{coulombs}$ Thermal Time Constant . . τ_i - 10 - msec

c Frequency at which the current transfer ratio is equal to 1.

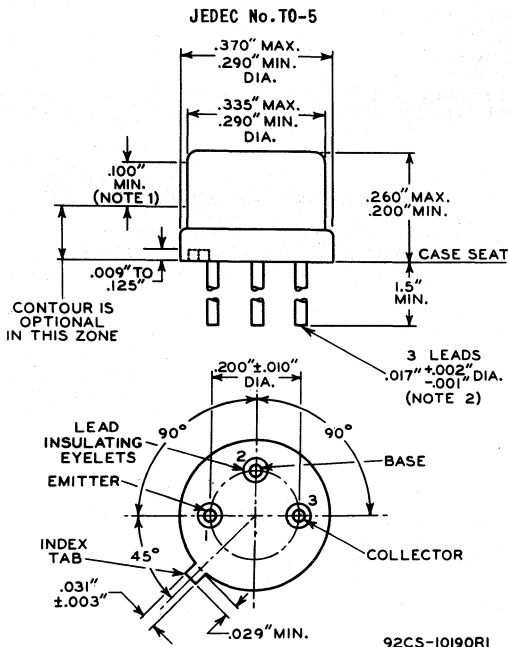
OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.



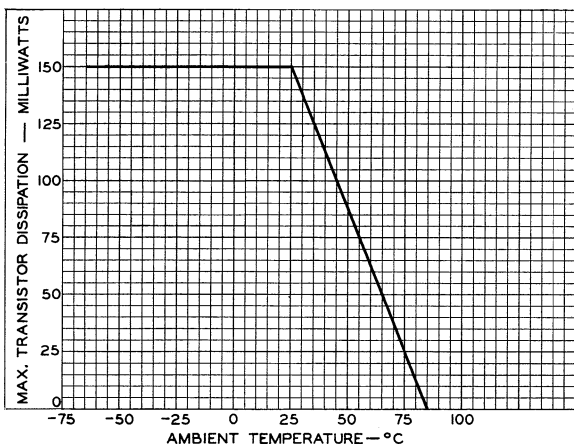
2N1300



NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

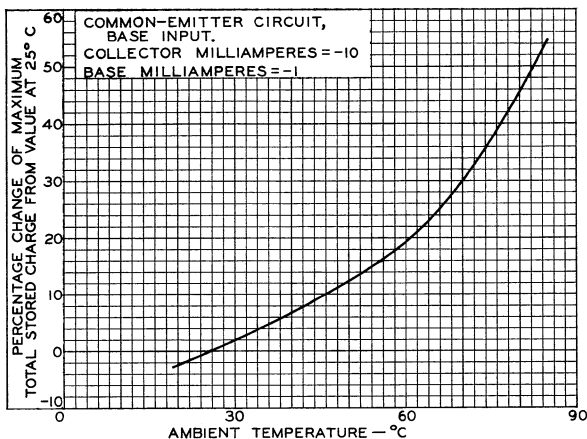
NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

RATING CHART



92CS-10232RI

OPERATION CHARACTERISTIC

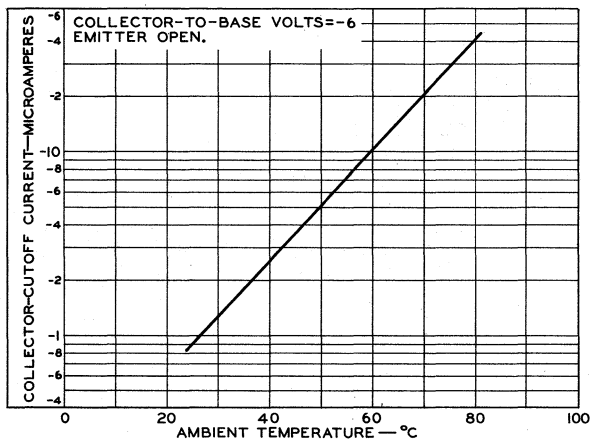


92CS-10226RI



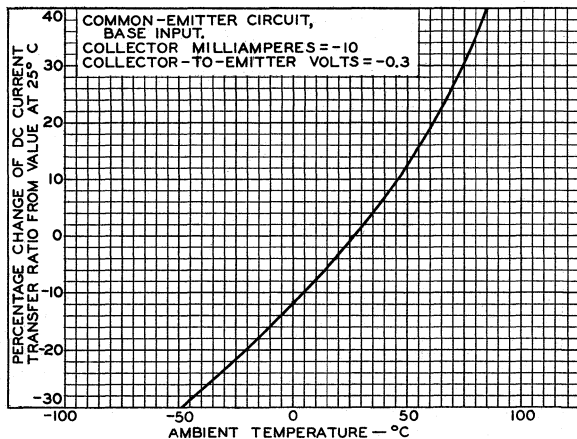
2N1300

TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTIC



92CS-10213RI

TYPICAL CHARACTERISTIC

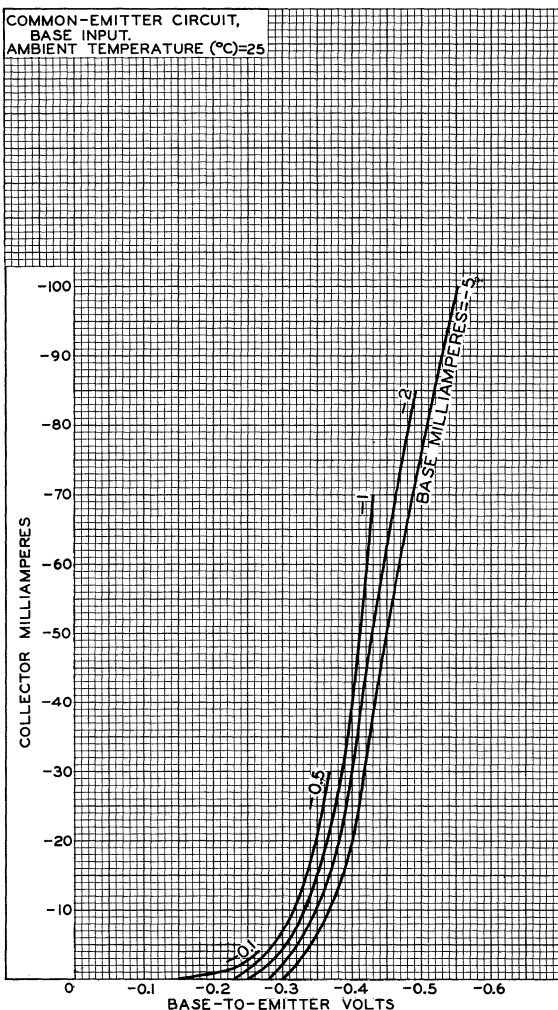


92CS-10199R3



TYPICAL TRANSFER CHARACTERISTICS

COMMON-EMITTER CIRCUIT,
BASE INPUT.
AMBIENT TEMPERATURE ($^{\circ}\text{C}$)=25



92CM-10229

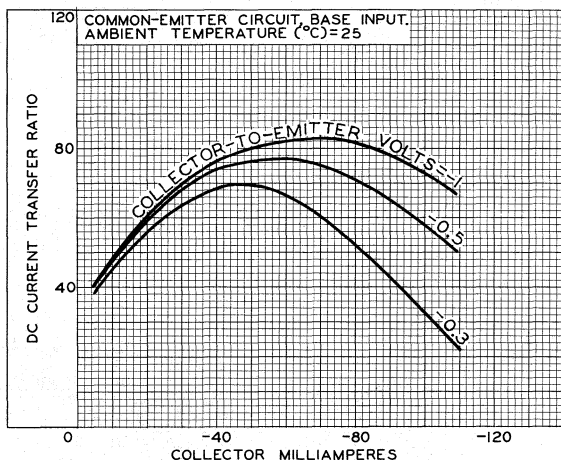


RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

DATA 4
4-61

2N1300

TYPICAL DC CURRENT-TRANSFER-RATIO CHARACTERISTICS



92CS-10829



Mesa Transistor

GERMANIUM P-N-P DIFFUSED-JUNCTION TYPE

For High-Speed Switching Service in Commercial and Military Data-Processing Systems

GENERAL DATA

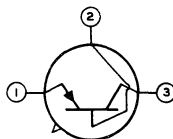
Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-5
Case.	Welded, Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter

Lead 3 - Collector

Lead 2 - Base



SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	-13 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE.	-12 max.	volts
EMITTER-TO-BASE VOLTAGE ^a	-4 max.	volts
COLLECTOR CURRENT	-100 max.	ma
EMITTER CURRENT	100 max.	ma

TRANSISTOR DISSIPATION:^b

At ambient temperature of 25° C	150 max.	mw
At ambient temperature of 55° C	75 max.	mw
At ambient temperature of 71° C	35 max.	mw

AMBIENT-TEMPERATURE RANGE:

Operating and storage	-65 to +85	°C
---------------------------------	------------	----

LEAD TEMPERATURE:

For immersion in molten solder		
for 10 seconds maximum.	255 max.	°C

Typical Operation:

In an inverter circuit at
ambient temperature of 25° C

Collector-to-Emitter Voltage.	-5	volts
Base Resistor	2400	ohms
Collector Resistor.	120	ohms
"Turn-On" Base Voltage.	-5	volts

← Indicates a change.



RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

DATA 1
4-61

"Turn-Off" Base Voltage.	5	volts
"On" Collector Current	-40	ma
"Turn-On" Base Current	-2	ma
"Turn-Off" Base Current.	2	ma
Switching Time:		
Delay time (t_d).	0.08	μ sec
Rise time (t_r)	0.07	μ sec
Storage time (t_s).	0.12	μ sec
Fall time (t_f)	0.07	μ sec

a This rating may be exceeded and the emitter-to-base junction operated in the breakdown condition provided the emitter dissipation is limited to 30 milliwatts at 25° C. For ambient temperatures above 25° C, the dissipation should be reduced by 0.5 milliwatt/°C.

b See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless otherwise specified. Ambient temperature of 25° C.

Min. Typical Max.

DC Collector Breakdown						
Voltage for dc collector ma. = -0.02, emitter open. BV_{CBO}						
	-13	-30	-			volts
DC Collector-to-Emitter Breakdown						
Voltage. BV_{CERL}						
	-12	-25	-			volts
DC Emitter Breakdown						
Voltage for dc emitter ma. = -0.1, collector open . . . BV_{EBO}						
	-4	-6	-			volts
DC Punch-Through						
Voltage. V_P						
	-12	-30	-			volts
→ DC Base-to-Emitter						
Voltage for dc collector ma. = -40, dc base ma. = -1 . . . V_{BE}						
	-	-0.4	-0.6			volt
DC Collector-Cutoff						
Current for collector volts = -6, emitter open I_{CBO}						
	-	-1	-3			μ a
→ Collector Capacitance						
for dc collector volts = -6, emitter open C_C						
	-	8	12			μ f
DC Current Transfer						
Ratio: h_{FE}						
With dc collector-to-emitter volts = -0.3, dc collector ma. = -10. . .						
	30	50	-			

→ Indicates a change.



With dc collector-to-emitter volts = -0.5, dc collector ma. = -40.	40	75	-	
Gain-Bandwidth Product ^c for dc collector-to-emitter volts = -3, dc collector ma. = -10 . . .GBW	35	60	-	Mc
Thermal Resistance: Junction-to-free air . . . R_T	-	-	400	°C/watt
Total Stored Charge: With dc collector ma. = -10, dc base ma. = -0.4.	-	225	325	μcoulombs
With dc collector ma. = -40, dc base ma. = -1.6.	-	600	800	μcoulombs
Thermal Time Constant. . . . τ_1	-	10	-	msec

^c Frequency at which the current transfer ratio is equal to 1.

OPERATING CONSIDERATIONS

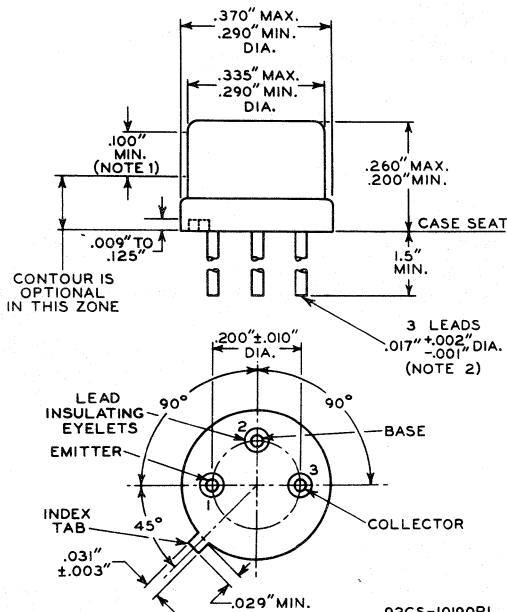
It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.



2N1301

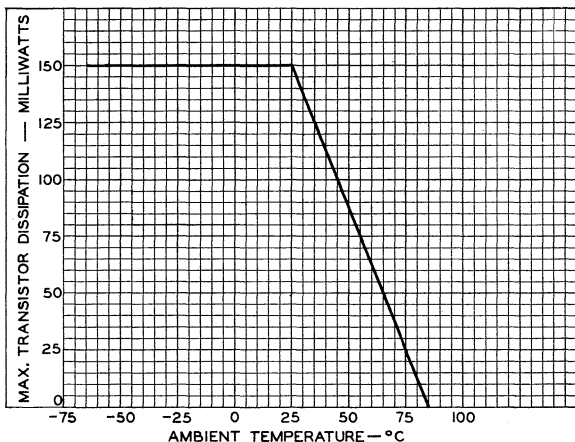
JEDEC No. T0-5



NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

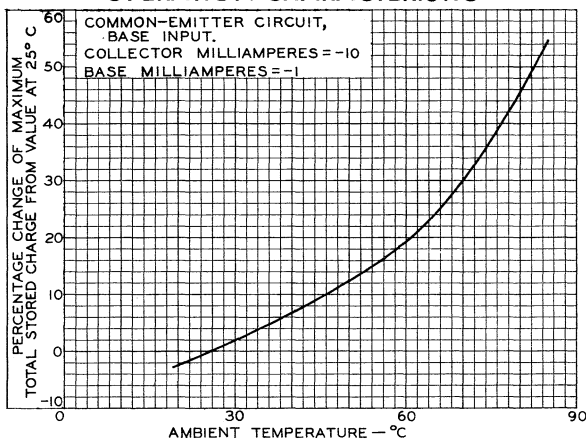
NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

RATING CHART



92CS-10232RI

OPERATION CHARACTERISTIC



92CS-10226RI

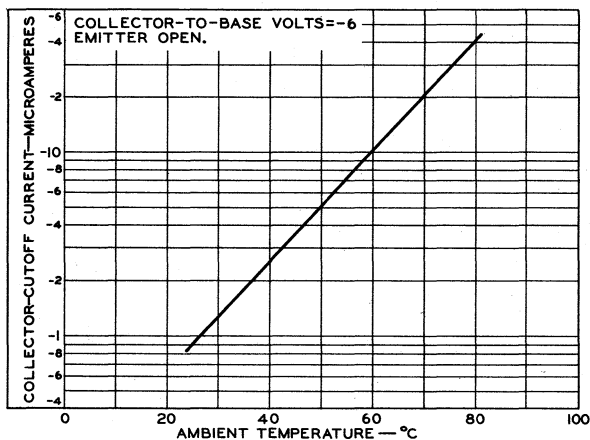


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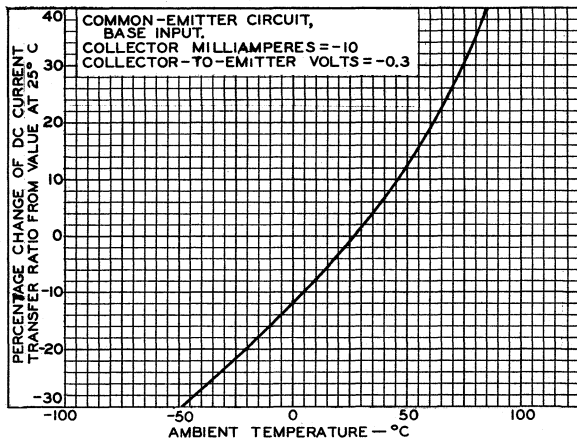
DATA 3
4-61

TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTIC



92CS-10213RI

TYPICAL CHARACTERISTIC

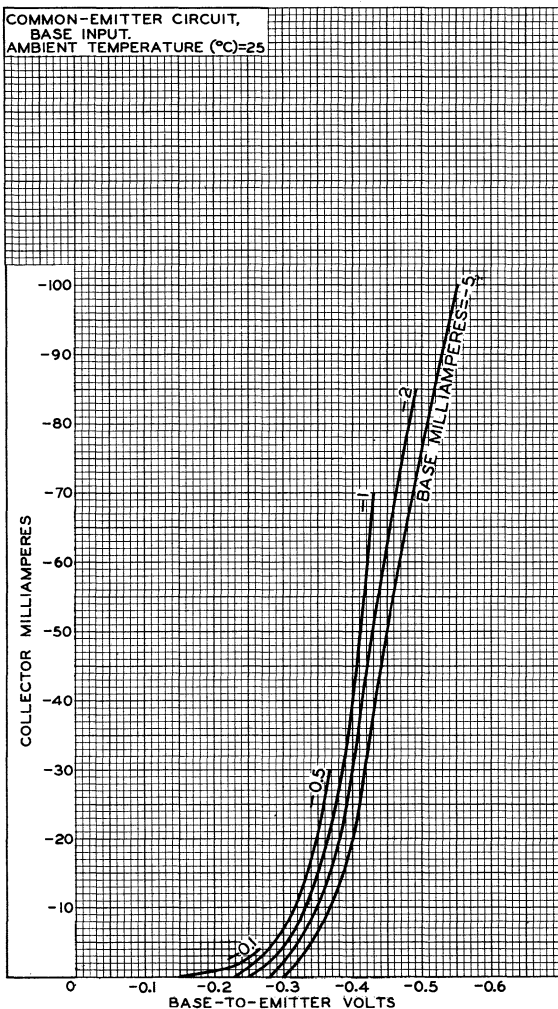


92CS-10199R3



TYPICAL TRANSFER CHARACTERISTICS

COMMON-EMITTER CIRCUIT,
BASE INPUT.
AMBIENT TEMPERATURE ($^{\circ}\text{C}$)=25



92CM-10229

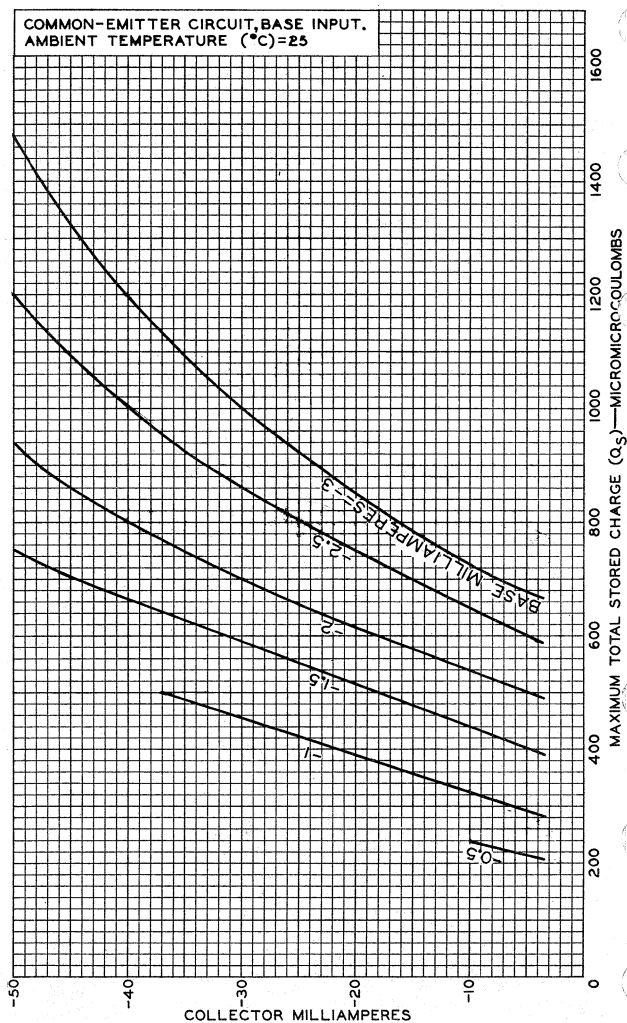


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Somerville, N. J.

DATA 4
4-61

2N1301

MAXIMUM TOTAL- STORED-CHARGE CHARACTERISTICS

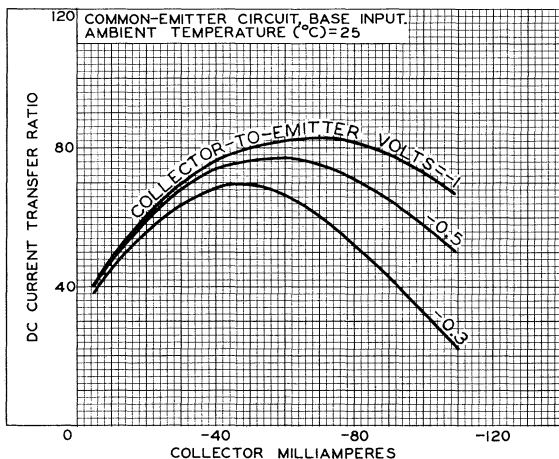


92CM-10228

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TYPICAL DC CURRENT-TRANSFER-RATIO CHARACTERISTICS



92CS-10829



Transistor

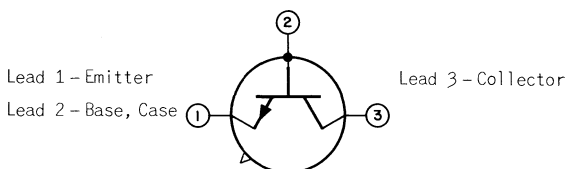
GERMANIUM N-P-N ALLOY-JUNCTION TYPE
For Switching Applications in Commercial
and Military Data-Processing Systems

GENERAL DATA

Mechanical:

Dimensions. See Outline TO-5 in General Section

Terminal Diagram: BOTTOM VIEW



SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CBO} 25 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EBO} 25 max. volts

COLLECTOR CURRENT. I_C 300 max. ma

TRANSISTOR DISSIPATION:^a

At free-air temperature of 25° C
or below P 150 max. mw

TEMPERATURE RANGE:

Storage. T_{stg} -65 to +100 °C

Operating (Junction) T_J -65 to +85 °C

LEAD TEMPERATURE:

For 10 seconds maximum^b. T_L 230 max. °C

^a See accompanying Rating Chart.

^b Measured 1/16" ± 1/32" down from seating plane.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless
otherwise specified. Free-air temperature of 25° C.

Min. Max.

DC Base-to-Emitter Voltage for dc
collector ma. = 10, dc base

ma. = 0.5. V_{BE} 0.15 0.4 volt

DC Collector-to-Emitter Satu-
ration Voltage for dc col-
lector ma. = 10, dc base ma.

= 0.5. $V_{CE(sat)}$ - 0.2 volt



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DATA 1
4-62

		Min.	Max.	
DC Collector-to-Emitter Reach-Through Voltage ^c	V _{RT}	25	-	volts
DC Collector-Cutoff Current for dc collector volts = 25, dc emitter ma. = 0	I _{CBO}	-	6	μa
DC Emitter-Cutoff Current for dc emitter volts = 25, dc collector ma. = 0	I _{EBO}	-	6	μa
Collector-to-Base Capacitance for dc collector volts = 5, dc emitter ma. = 0	C _{ob}	-	20	pf
DC Forward Current Transfer Ratio: h _{FE}				
With dc collector-to-emitter volts = 1, dc collector ma. = 10.		20	-	
With dc collector-to-emitter volts = 0.35, dc collector ma. = 200.		10	-	
Alpha-Cutoff Frequency for dc collector volts = 5, dc emitter ma. = 1	f _{ab}	3	-	Mc

^c The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of +1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.

PERFORMANCE TESTS

This transistor type is tested in strict accordance with Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

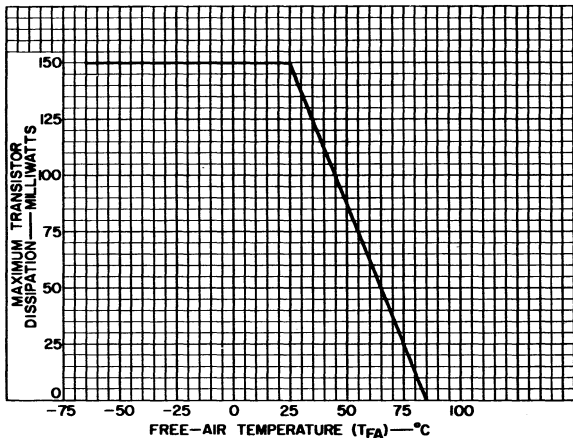
It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board, and to prevent the base from shorting to ground.

It is to be noted that the case of this transistor operates at the base voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

RATING CHART



92CS-11462





Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

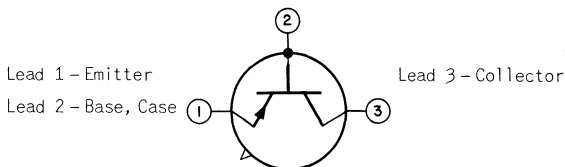
For Switching Applications in Commercial
and Military Data-Processing Systems

GENERAL DATA

Mechanical:

Dimensions. See Outline TO-5 in General Section

Terminal Diagram: BOTTOM VIEW



SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CB0} -30 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EB0} -25 max. volts

COLLECTOR CURRENT. I_C -300 max. ma

TRANSISTOR DISSIPATION:^a

At free-air temperature of
25° C or below P 150 max. mw

TEMPERATURE RANGE:

Storage. T_{stg} -65 to +100 °C

Operating (Junction) T_J -65 to +85 °C

LEAD TEMPERATURE:

For 10 seconds maximum^b. T_L 230 max. °C

^a See accompanying Rating Chart.

^b Measured 1/16" ± 1/32" down from seating plane.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless
otherwise specified. Free-air temperature of 25° C.

Min. Max.

DC Base-To-Emitter Voltage for

dc collector ma. = -10, dc
base ma. = -0.5. V_{BE} -0.15 -0.4 volt

DC Collector-to-Emitter Satu-

ration Voltage for dc col-
lector ma. = -10, dc base
ma. = -0.5. $V_{CE(sat)}$ - -0.2 volt



Min. Max.

DC Collector-to-Emitter Reach-Through Voltage ^c	V_{RT}	-25	-	volts
DC Collector-Cutoff Current for dc collector volts = -25, dc emitter ma. = 0	I_{CBO}	-	-6	μa
DC Emitter-Cutoff Current for dc emitter volts = -25, dc collector ma. = 0	I_{EBO}	-	-6	μa
Collector-to-Base Capacitance for dc collector volts = -5, dc emitter ma. = 0	C_{ob}	-	20	pf
DC Forward Current Transfer Ratio: With dc collector-to-emitter volts = -1, dc collector ma. = -10. . .	h_{FE}	20	-	
With dc collector-to-emitter volts = -0.35, dc collector ma. = -200. . .		10	-	
Alpha-Cutoff Frequency for dc collector volts = -5, dc emitter ma. = 0	$f_{\alpha b}$	3	-	Mc

^c The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of -1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.

PERFORMANCE TESTS

This transistor type is tested in strict accordance with Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

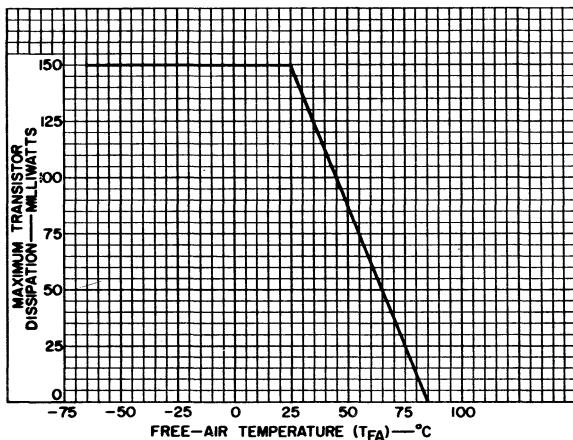
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board, and to prevent the base from shorting to ground.



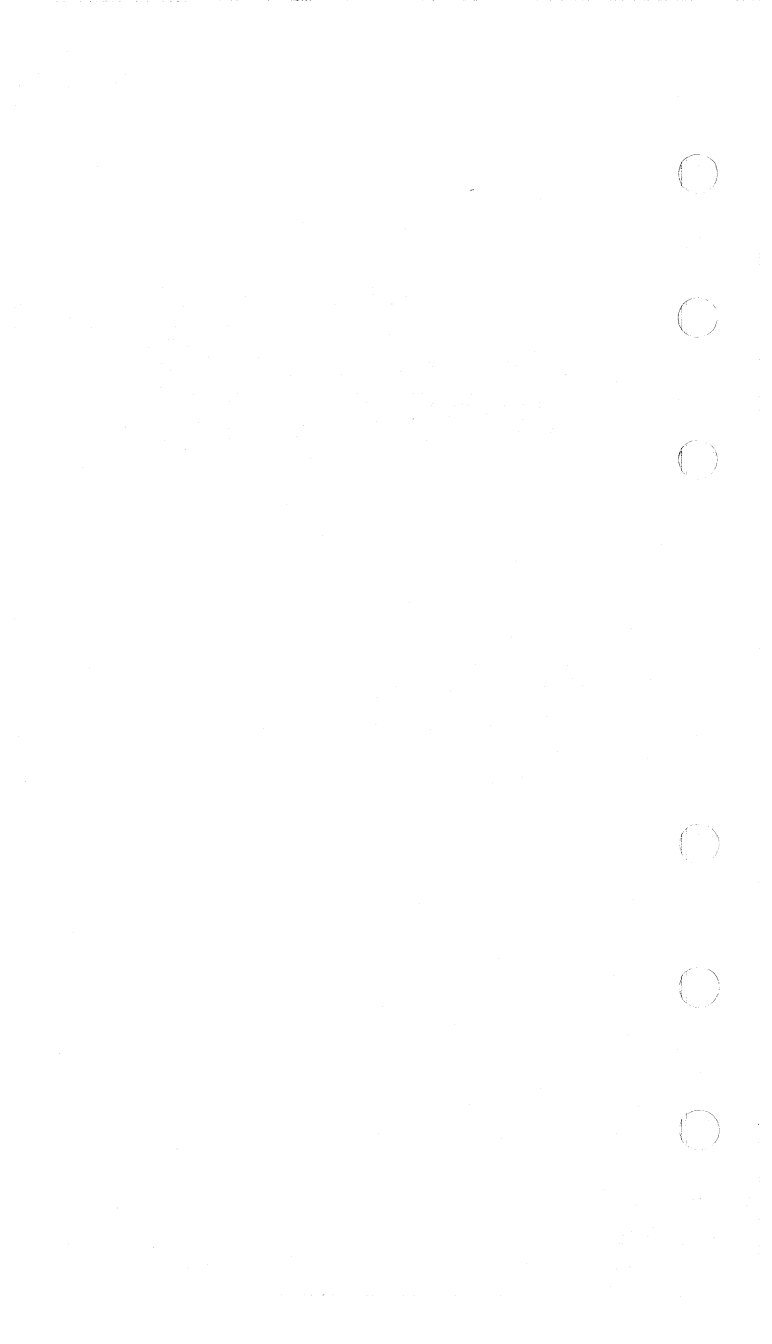
It is to be noted that the case of this transistor operates at the base voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

RATING CHART



92CS-11462





Transistor

GERMANIUM N-P-N ALLOY-JUNCTION TYPE

For Switching Applications in Commercial
and Military Data-Processing Systems

The 2N1304 is the same as the 2N1302 except for the following items:

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless
otherwise specified. Free-air temperature of 25° C.

Min. Max.

DC Base-to-Emitter Voltage for dc collector ma. = 10, dc base ma. = 0.5.	V_{BE}	0.15	0.35	volt
DC Collector-to-Emitter Satu- ration Voltage for dc collector ma. = 10, dc base ma. = 0.25	$V_{CE(sat)}$	-	0.2	volt
DC Collector-to-Emitter Reach- Through Voltage ^c	V_{RT}	20	-	volts
DC Collector-Cutoff Current for dc collector volts = 25, dc emitter ma. = 0	I_{CBO}	-	6	μa
DC Emitter-Cutoff Current for dc emitter volts = 25, dc collector ma. = 0	I_{EBO}	-	6	μa
Collector-to-Base Capacitance for dc collector volts = 5, dc emitter ma. = 0	C_{ob}	-	20	pf
DC Forward Current Transfer Ratio: With dc collector-to-emitter volts = 1, dc collector ma. = 10.	h_{FE}	40	200	
With dc collector-to-emitter volts = 0.35, dc collector ma. = 200		15	-	
Alpha-Cutoff Frequency for dc collector volts = 5, dc emitter ma. = 1	$f_{\alpha b}$	5	-	Mc

^c The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of +1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.





Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

For Switching Applications in Commercial
and Military Data-Processing Systems

The 2N1305 is the same as the 2N1303 except for the following items:

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless otherwise specified. Free-air temperature of 25° C.

Min. Max.

DC Base-to-Emitter Voltage for dc collector ma. = -10, dc base ma. = -0.5.	V_{BE}	-0.15	-0.35	volt
DC Collector-to-Emitter Satu- ration Voltage for dc collector ma. = -10, dc base ma. = -0.25.	$V_{CE(sat)}$	-	-0.2	volt
DC Collector-to-Emitter Reach- Through Voltage ^c	V_{RT}	-20	-	volts
DC Collector-Cutoff Current for dc collector volts = -25, dc emitter ma. = 0. . . .	I_{CBO}	-	-6	μa
DC Emitter-Cutoff Current for dc emitter volts = -25, dc collector ma. = 0.	I_{EBO}	-	-6	μa
Collector-to-Base Capacitance for dc collector volts = -5, dc emitter ma. = 0.	C_{ob}	-	20	pf
DC Forward Current Transfer Ratio:	h_{FE}			
With dc collector-to-emitter volts = -1, dc collector ma. = -10.		40	200	
With dc collector-to-emitter volts = -0.35, dc collector ma. = -200. . . .		15	-	
Alpha-Cutoff Frequency for dc collector volts = -5, dc emitter ma. = 0.	f_{ab}	5	-	Mc

^c The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of -1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.





Transistor

GERMANIUM N-P-N ALLOY-JUNCTION TYPE

For Switching Applications in Commercial
and Military Data-Processing Systems

The 2N1306 is the same as the 2N1302 except for the following items:

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless
otherwise specified. Free-air temperature of 25° C.

Min. Max.

DC Base-to-Emitter Voltage for dc collector ma. = 10, dc base ma. = 0.5	V_{BE}	0.15	0.35	volt
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 10, dc base ma. = 0.17.	$V_{CE(sat)}$	-	0.2	volt
DC Collector-to-Emitter Reach- Through Voltage ^c	V_{RT}	15	-	volts
DC Collector-Cutoff Current for dc collector volts = 25, dc emitter ma. = 0.	I_{CBO}	-	6	μ a
DC Emitter-Cutoff Current for dc emitter volts = 25, dc collector ma. = 0.	I_{EBO}	-	6	μ a
Collector-to-Base Capacitance for dc collector volts = 5, dc emitter ma. = 0.	C_{ob}	-	20	pf
DC Forward Current Transfer Ratio: With dc collector-to-emitter volts = 1, dc collector ma. = 10.	h_{FE}	60	300	
With dc collector-to-emitter volts = 0.35, dc collector ma. = 200		20	-	
Alpha-Cutoff Frequency for dc collector volts = 5, dc emitter ma. = 1.	f_{ab}	10	-	Mc

^c The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of +1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.





Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

For Switching Applications in Commercial
and Military Data-Processing Systems

The 2N1307 is the same as the 2N1303 except for the following items:

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless otherwise specified. Free-air temperature of 25° C.

		Min.	Max.	
DC Base-to-Emitter Voltage for dc collector ma. = -10, dc base ma. = -0.5	V_{BE}	-0.15	-0.35	volt
DC Collector-to-Emitter Satu- ration Voltage for dc collector ma. = -10, dc base ma. = -0.17	$V_{CE(sat)}$	-	-0.2	volt
DC Collector-to-Emitter Reach- Through Voltage ^c	V_{RT}	-15	-	volts
DC Collector-Cutoff Current for dc collector volts = -25, dc emitter ma. = 0. . .	I_{CBO}	-	-6	μa
DC Emitter-Cutoff Current for dc emitter volts = -25, dc collector ma. = 0.	I_{EBO}	-	-6	μa
Collector-to-Base Capacitance for dc collector volts = -5, dc emitter ma. = 0	C_{ob}	-	20	pf
DC Forward Current Transfer Ratio:	h_{FE}			
With dc collector-to-emitter volts = -1, dc collector ma. = -10.		60	300	
With dc collector-to-emitter volts = -0.35, dc collector ma. = -200 . . .		20	-	
Alpha-Cutoff Frequency for dc collector volts = -5, dc emitter ma. = 0.	f_{ab}	10	-	Mc

^c The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of -1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.





Transistor

GERMANIUM N-P-N ALLOY-JUNCTION TYPE

For Switching Applications in Commercial
and Military Data-Processing Systems

The 2N1308 is the same as the 2N1302 except for the following items:

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless
otherwise specified. Free-air temperature of 25° C.

Min. Max.

DC Base-to-Emitter Voltage for dc collector ma. = 10, dc base ma. = 0.5	V_{BE}	0.15	0.35	volt
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 10, dc base ma. = 0.13.	$V_{CE(sat)}$	—	0.2	volt
DC Collector-to-Emitter Reach- Through Voltage ^c	V_{RT}	15	—	volts
DC Collector-Cutoff Current for dc collector volts = 25, dc emitter ma. = 0.	I_{CBO}	—	6	μ a
DC Emitter-Cutoff Current for dc emitter volts = 25, dc collector ma. = 0.	I_{EBO}	—	6	μ a
Collector-to-Base Capacitance for dc collector volts = 5, dc emitter ma. = 0.	C_{ob}	—	20	pf
DC Forward Current Transfer Ratio:	h_{FE}			
With dc collector-to-emitter volts = 1, dc collector ma. = 10.		80	—	
With dc collector-to-emitter volts = 0.35, dc collector ma. = 200.		20	—	
Alpha-Cutoff Frequency for dc collector volts = 5, dc emitter ma. = 1.	f_{ab}	15	—	Mc

^c The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of +1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.





Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

For Switching Applications in Commercial
and Military Data-Processing Systems

The 2N1309 is the same as the 2N1303 except for the following items:

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless otherwise specified. Free-air temperature of 25° C.

		Min.	Max.	
DC Base-to-Emitter Voltage for dc collector ma. = -10, dc base ma. = -0.5.	V_{BE}	-0.15	-0.35	volt
DC Collector-to-Emitter Satu- ration Voltage for dc col- lector ma. = -10, dc base ma. = -0.13.	$V_{CE(sat)}$	-	-0.2	volt
DC Collector-to-Emitter Reach- Through Voltage ^c	V_{RT}	-15	-	volts
DC Collector-Cutoff Current for dc collector volts = -25, dc emitter ma. = 0. . .	I_{CBO}	-	-6	μ a
DC Emitter-Cutoff Current for dc emitter volts = -25, dc collector ma. = 0.	I_{EBO}	-	-6	μ a
Collector-to-Base Capacitance for dc collector volts = -5, dc emitter ma. = 0.	C_{ob}	-	20	pf
DC Forward Current Transfer Ratio:	h_{FE}			
With dc collector-to-emitter volts = -1, dc collector ma. = -10.		80	-	
With dc collector-to-emitter volts = -0.35, dc col- lector ma. = -200.		20	-	
Alpha-Cutoff Frequency for dc collector volts = -5, dc emitter ma. = 0.	f_{ab}	15	-	Mc

^c The dc collector-to-emitter (reach-through) voltage is determined by connecting a high-impedance voltmeter (11 megohms or greater) between the emitter and base and measuring the collector-to-base voltage which causes the emitter to assume an emitter-to-base floating voltage of -1 volt. Care must be taken so that the maximum collector-to-base voltage (specified under Maximum Ratings) is not exceeded.





Power Transistor

GERMANIUM P-N-P ALLOY TYPE

For Power Switching and Amplifier Service
in Industrial and Military Applications

The 2N1358 is the same as the 2N174 except for the following items:

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^a of 25° C unless otherwise specified

Min. Typical Max.

DC Collector-to-Emitter Break-down Voltage:				
With base connected to emitter, dc collector amperes = -0.3				
	BV_{CES}	-70	-	volts
With base open, dc collector amperes = -0.3				
	BV_{CEO}	-40	-	volts
DC Base-to-Emitter Voltage:				
With dc collector volts = -2, dc collector amperes = -1.2				
	V_{BE}	-	0.35	0.5 volt
With dc collector-to-emitter volts = -2, dc collector amperes = -5.				
		-	-0.65	-0.9 volt
DC Collector-to-Emitter Saturation Voltage for dc collector amperes = -12, dc base amperes = -2.				
	$V_{CE(sat)}$	-	-0.3	-0.7 volt
DC Emitter Voltage for dc collector volts = -80, dc collector current = 0				
	V_{EB}	-	-0.15	-1 volt
DC Punch-Through Voltage.				
	V_{PT}	-80	-	volts
DC Emitter-Cutoff Current:				
With dc emitter volts = -30, dc collector current = 0, case temperature ^a = 71° C.				
	I_{EBO}	-	-4	-6 ma
With dc emitter volts = -60, dc collector current = 0.				
		-	-1	-4 ma
DC Collector-Cutoff Current:				
With dc collector volts = -2, dc emitter current = 0				
	I_{CBO}	-	-100	-200 μ a
With dc collector volts = -30, dc emitter current = 0, case temperature ^a = 71° C				
		-	-4	-6 ma
With dc collector volts = -80, dc emitter current = 0				
		-	-2	-4 ma

← Indicates a change.



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DATA
8-61

2N1358

With dc collector volts =				
-80, dc emitter current				
= 0, case temperature ^a =				
71° C.				
DC Current Transfer Ratio	h_{FE}	-	-	-15 ma
for dc collector-to-				
emitter volts = -2, dc				
collector amperes =				
-5	25	35	-	
-1.2	40	55	80	
Beta-Cutoff Frequency for				
dc collector volts = -12,				
dc collector amperes = -1.				
	$f_{\alpha e}$	100	-	- kc
Thermal Resistance:				
Junction-to-case	R_T	-	0.35	0.5 °C/watt
Thermal Capacity for pulse				
duration of 1 to 10				
milliseconds				
		-	0.075	- watt- sec/°C
Thermal Time Constant.	τ_l	-	26.25	- msec

^a Measured at any point on seating surface.



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For High-Speed Switching Circuits in Industrial and Military Electronic Computers

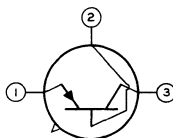
GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.390"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-11
Case.	Welded, Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1—Emitter

Lead 2—Base



Lead 3—Collector

SWITCHING SERVICE

Such as in memory-core-driver, pulse-amplifier, inverter, flip-flop, and logic-gate circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	-30 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE	-30 max.	volts
EMITTER-TO-BASE VOLTAGE ^a	-1 max.	volt
COLLECTOR CURRENT	-500 max.	ma
EMITTER CURRENT	500 max.	ma

TRANSISTOR DISSIPATION:^b

At ambient temperature of 25° C	240 max.	mw
At ambient temperature of 55° C	120 max.	mw
At ambient temperature of 71° C	56 max.	mw

AMBIENT-TEMPERATURE RANGE:

Operating and storage	-65 to +85	°C
---------------------------------	------------	----

Typical Operation:

In an inverter circuit at ambient temperature of 25° C

"On" Collector Current	-200	ma
"Turn-On" Base Current	-20	ma
"Turn-Off" Base Current	20	ma

Switching Time:

Delay time (t_d)	0.02	μsec
Rise time (t_r)	0.08	μsec



Storage time (t_s) 0.25 μ sec
 Fall time (t_f) 0.1 μ sec

^a This rating may be exceeded and the emitter-to-base junction operated in the breakdown condition provided the emitter dissipation is limited to 30 milliwatts at 25° C. For ambient temperatures above 25° C, reduce the dissipation by 0.5 milliwatt/°C.

^b See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to the base unless otherwise specified. Ambient temperature of 25° C.

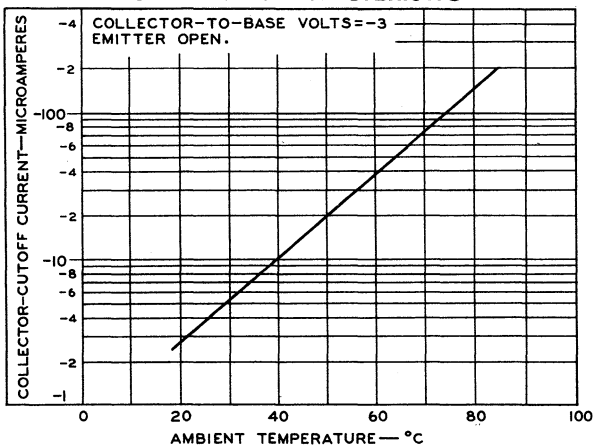
Min. Typical Max.

DC Collector Breakdown					
Voltage for dc collector $\mu_a = -100$					
with emitter open	BV_{CBO}	-30	-55	-	volts
DC Collector-to-Emitter Breakdown					
Voltage		-30	-40	-	volts
DC Emitter Breakdown					
Voltage for dc emitter $\mu_a = -100$					
with collector open	BV_{EBO}	-1	-3	-	volts
DC Punch-Through					
Voltage for dc emitter volts = -1.					
	V_P	-30	-50	-	volts
→ DC Base-to-Emitter					
Voltage for dc collector ma. = -200, dc base ma. = -10					
	V_{BE}	-	-0.6	-0.9	volt
→ DC Collector-Cutoff					
Current for dc collector volts = -3 with emitter open					
	I_{CBO}	-	-4	-8	μ a
DC Current Transfer					
Ratio for dc collector-to-emitter volts = -0.5, dc collector ma. = -200.					
	h_{FE}	20	50	-	
Gain-Bandwidth Product ^c for collector-to-emitter volts = -3, collector ma. = -10					
	GBW	20	35	-	Mc
Thermal Time Constant.					
	τ_1	-	14	-	msec
Thermal Resistance between collector junction and free air.					
	R_T	-	-	250	°C/watt
Stored Base Charge for dc collector ma. = -10, dc base ma. = -1.					
	Q_S	-	600	800	μ coulombs

^c Frequency at which the current transfer ratio is equal to 1.

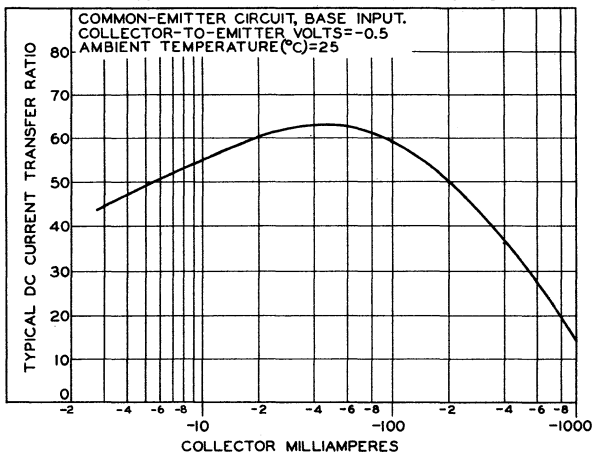
→ Indicates a change.

TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTIC



92CS-10568

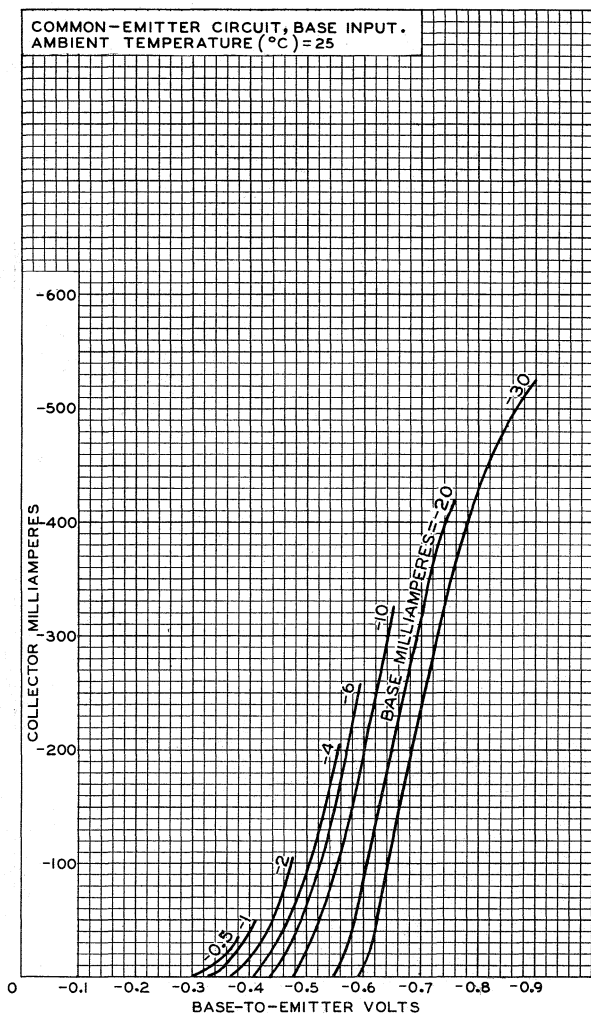
TYPICAL DC CURRENT-TRANSFER-RATIO CHARACTERISTIC



92CS-10579RI



TYPICAL TRANSFER CHARACTERISTICS



92CM-10574R2



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Industrial and Military Applications

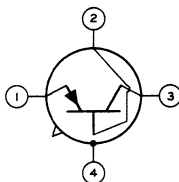
The 2N1395 is the same as the 2N274 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads) 0.260"
 Maximum Diameter 0.370"
 Dimensional Outline. JEDEC No. TO-33
 Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector
 Lead 4 - Interlead
 Shield,
 Case

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Typical Value	Range Values	
		Min.	Max.
Small-Signal Current Transfer Ratio (h_{fe}) for dc collector- to-emitter volts = -12, dc emitter ma. = 1.5, signal frequency of 1 kc. . .	90	50	175

OPERATING CONSIDERATIONS

shown under Type 2N274 also apply to the 2N1395
 with the addition of the following:

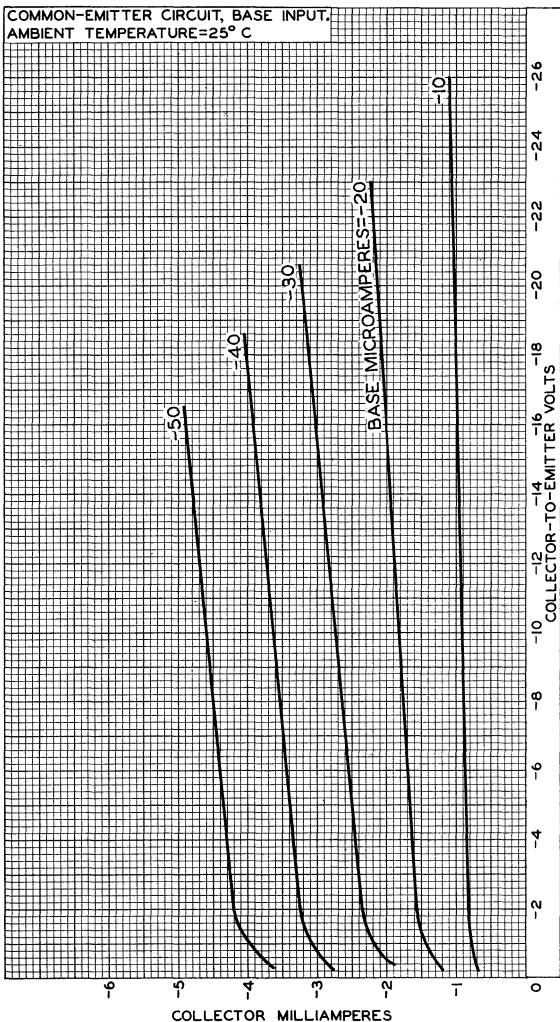
This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.

VIDEO-AMPLIFIER CIRCUIT

shown under Type 2N274 also applies to the 2N1395



TYPICAL COLLECTOR CHARACTERISTICS



92CM-10398



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE
For Industrial and Military Applications

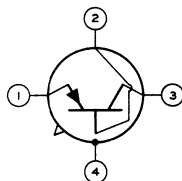
The 2N1396 is the same as the 2N384 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads) 0.260"
Maximum Diameter. 0.370"
Dimensional Outline JEDEC No. TO-33
Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector
Lead 4 - Interlead
Shield,
Case

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Typical Value	Range Values	
		Min.	Max.
Small-Signal Current Transfer Ratio (h_{fe}) for dc collector- to-emitter volts = -12, dc emitter ma. = 1.5, and signal frequency of 1 kc. . . .	90	50	175

OPERATING CONSIDERATIONS

shown under Type 2N384 also apply to the 2N1396
with the addition of the following:

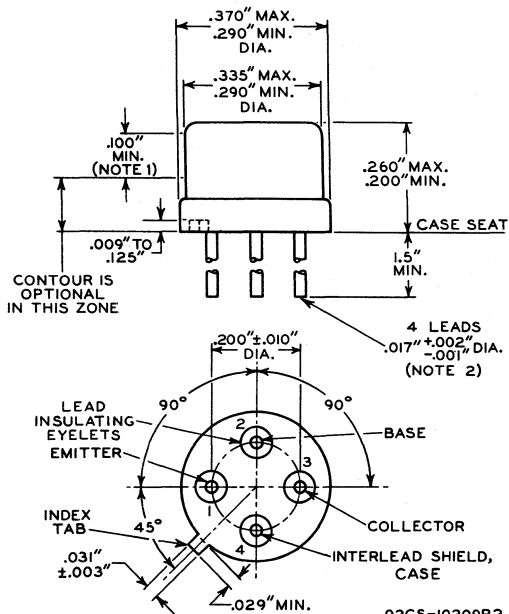
This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.

VIDEO-AMPLIFIER CIRCUIT

shown under Type 2N384 also applies to the 2N1396



2N1396



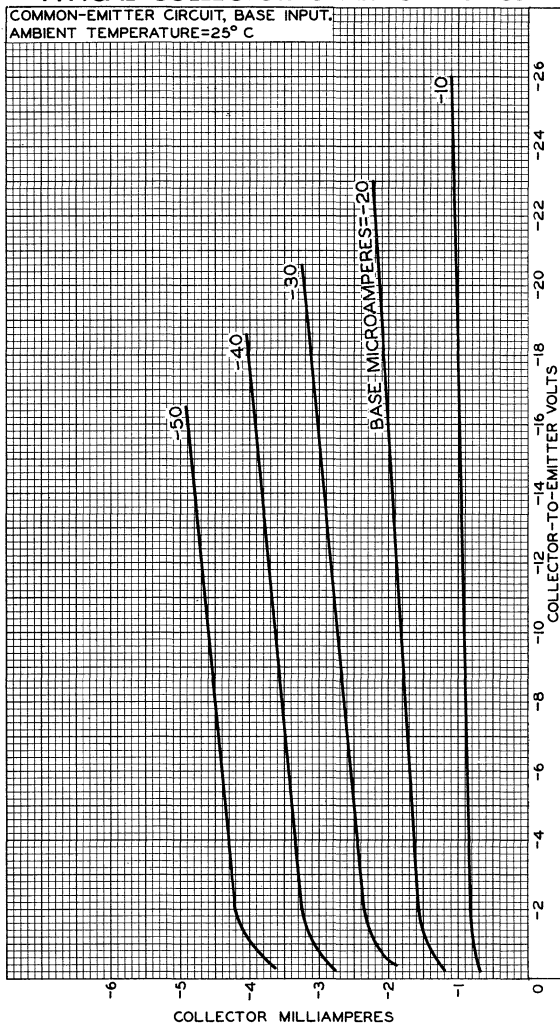
NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

RATING CHART
and **PERFORMANCE CHARACTERISTICS**
shown under Type 2N384 also apply to the 2N1396

TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT,
AMBIENT TEMPERATURE=25° C



92CM-10398



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Semiconductor & Materials Division
Somerville, N. J.

DATA 2
3-60

Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE
For Industrial and Military Applications

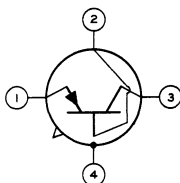
The 2N1397 is the same as the 2N1023 except for the following items:

Mechanical:

Maximum Length (Excluding flexible leads) 0.260"
Maximum Diameter 0.370"
Dimensional Outline. JEDEC No. TO-33
Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector
Lead 4 - Interlead
Shield,
Case

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Typical Value	Range Values	
		Min.	Max.
Small-Signal Current Transfer Ratio (h_{fe}) for dc collector-to-emitter volts = -12, dc emitter ma. = 1.5, signal frequency of 1 kc	90	50	175

OPERATING CONSIDERATIONS

shown under Type 2N1023 also apply to the 2N1397 with the addition of the following:

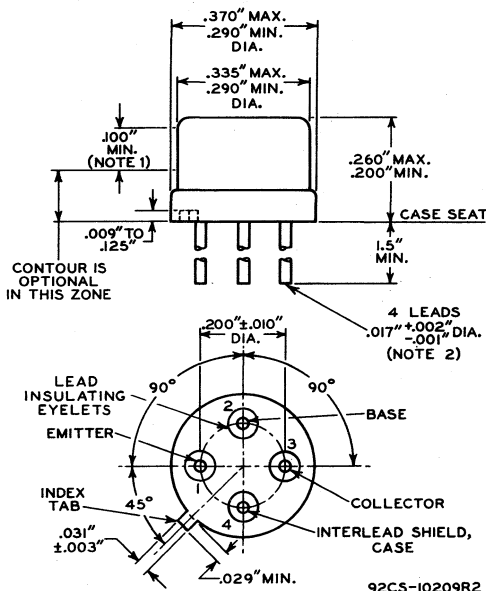
This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board.

VIDEO-AMPLIFIER CIRCUIT

shown under Type 2N1023 also applies to the 2N1397



2N1397



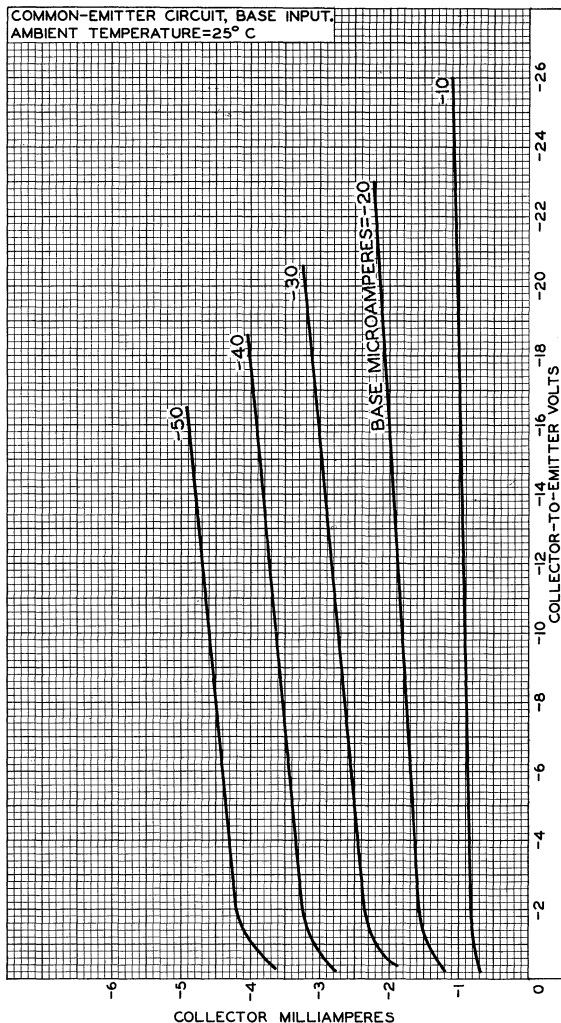
NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

RATING CHART
and **PERFORMANCE CHARACTERISTICS**
shown under Type 2N1023 also apply to the 2N1397

TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE=25° C



92CM-10398



RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

DATA 2
3-60



Power Transistor

GERMANIUM P-N-P ALLOY TYPE

For Power Switching and Amplifier Service
in Industrial and Military Applications

The 2N1412 is the same as the 2N1100 except for the following items:

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and audio-
amplifier, relay- and solenoid-actuating circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

EMITTER-TO-BASE VOLTAGE. -60 max. volts

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at
case temperature^a of 25° C unless otherwise specified

Min. Typical Max.

DC Base-to-Emitter Voltage for dc collector-to-emitter volts = -2, dc collector amperes = -5	V_{BE} -	-0.65	-0.8	volt
DC Emitter-Cutoff Current for dc emitter volts = -60, dc collector current = 0. . .	I_{EBO} -	-1	-4	ma

^a Measured at any point on seating surface.

← Indicates a change.



Power Transistor

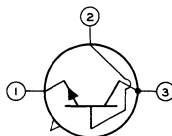
SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-5
Case.	Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter
 Lead 2 - Base



Lead 3 - Collector,
 Case

INDUSTRIAL SERVICE

*Such as in dc-to-dc converter, inverter, chopper,
 voltage- and current-regulator, dc- and servo-
 amplifier, relay- and solenoid-actuating circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	60 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With emitter-to-base reverse biased (DC emitter-to-base volts = 1.5).	60 max.	volts
With base open (Sustaining voltage) ^a	40 max.	volts
EMITTER-TO-BASE VOLTAGE	12 max.	volts
COLLECTOR CURRENT	1.5 max.	amp
EMITTER CURRENT	-1.75 max.	amp
BASE CURRENT.	1 max.	amp
TRANSISTOR DISSIPATION: ^b		
At case temperature of 25° C.	5 max.	watts
At case temperature of 100° C.	2.86 max.	watts
CASE-TEMPERATURE RANGE: ^c		
Operating and storage	-65 to +200	°C

Characteristics:

At case temperature of 25° C

Small-Signal Current Transfer Ratio (h_{fe})

with dc collector-to-emitter volts =

4, dc collector ma. = 5 50

← Indicates a change.



RADIO CORPORATION OF AMERICA
 Semiconductor & Materials Division
 Somerville, N. J.

DATA 1
 6-61

Alpha-Cutoff Frequency (f_{ab}) with dc collector-to-base volts = 28, dc collector ma. = 5.	1.5	Mc
Collector-to-Base Capacitance (C_{ob}) with dc collector-to-base volts = 40	150	$\mu\mu\text{f}$
Thermal Time Constant (τ_1)	10	msec

Typical Operation:

In accompanying typical power-switching circuit at case temperature^c of 25° C

DC Supply Voltage (B_2)	12	volts
DC Base-Bias Voltage (B_1)	-8.5	volts
"On" DC Collector Current.	200	ma
"Turn-On" Base Current (I_{B1})	20	ma
"Turn-Off" Base Current (I_{B2})	-8.5	ma
Generator Resistance	50	ohms
Switching Time:		
Delay time (t_d)	0.2	μsec
Rise time (t_r)	1	μsec
Storage time (t_s)	0.6	μsec
Fall Time (t_f)	1	μsec

^a The Collector-to-Emitter Sustaining Voltage ($V_{CE(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^b See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

^c Measured at center of seating surface.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base and case temperature^c of 25° C unless otherwise specified

Min. Max.

Collector-to-Emitter Voltage:

With emitter reverse bias volts = 1.5, dc collector ma. = 0.25 V_{CEX} 60 - volts

With base open (Sustaining voltage), dc collector ma. = 50, dc base ma. = 0. V_{CEO}^a (sus) 40 - volts

Base-to-Emitter Voltage for dc collector-to-emitter volts = 4, dc collector ma. = 200. V_{BE} - 3 volts
 I_{CBO}

→ Collector-Cutoff Current for dc collector volts = 30, dc emitter ma. = 0, case temperature =
25° C - 10 μa
150° C - 500 μa

→ indicates a change.

Emitter-Cutoff Current for					
dc emitter volts = 12,					
dc collector ma. = 0	I_{EBO}	-	10	μa	←
DC Current Transfer Ratio					
for dc collector-to-emitter					
volts = 4, dc collector ma.					
= 200.	h_{FE}	20	60		
DC Collector-to-Emitter					
Saturation Resistance for					
dc collector ma. = 200, dc					
base ma. = 20.	R_S	-	7	ohms	←
Thermal Resistance:	R_T				
Junction-to-case		-	35	$^{\circ}C/watt$	
Junction-to-free air		-	200	$^{\circ}C/watt$	

^a The Collector-to-Emitter Sustaining Voltage ($V_{CE0(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^c Measured at center of seating surface.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using this transistor, the temperature of the solder should not exceed $255^{\circ}C$ for a maximum immersion period of 10 seconds.

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in-type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board, and to prevent the collector from shorting to ground.

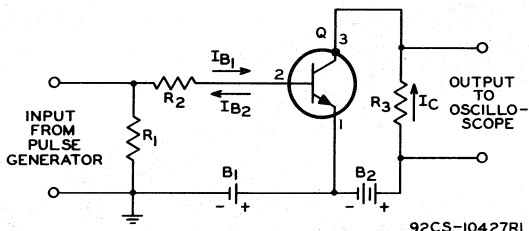
It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

← Indicates a change.



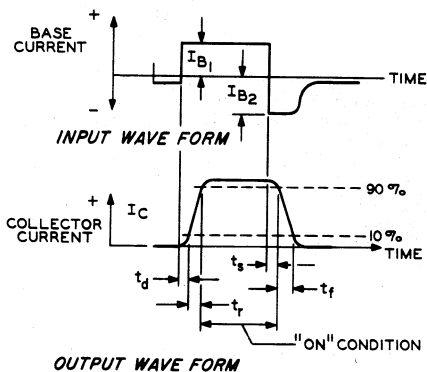
2N1479

TYPICAL POWER-SWITCHING CIRCUIT



B_1 : 8.5 volts
 B_2 : 12 volts
 Q : Transistor type 2N1479
 R_1 : 50 ohms, 1 watt
 R_2 : 700 ohms, 1 watt
 R_3 : 59 ohms, 2 watts

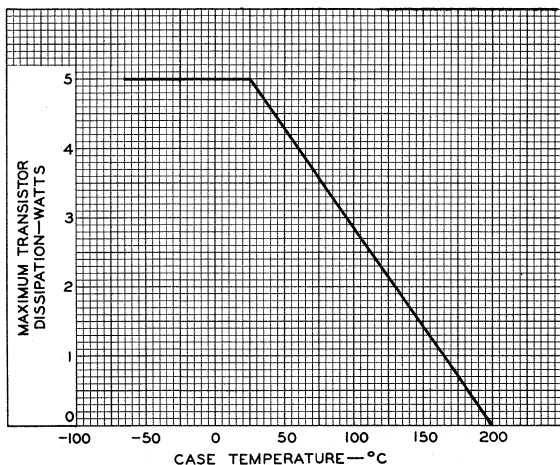
ASSOCIATED WAVE FORMS



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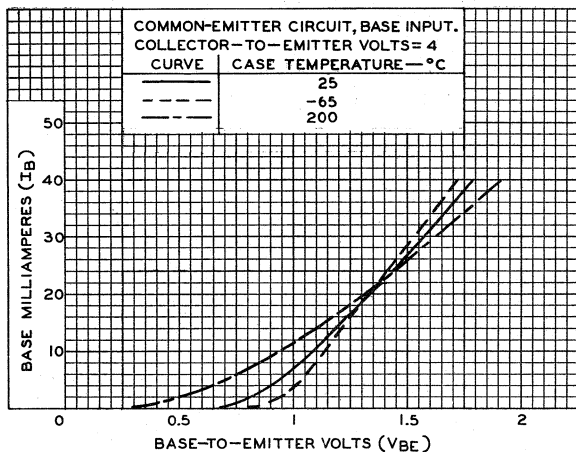


RATING CHART



92CS-10446R2

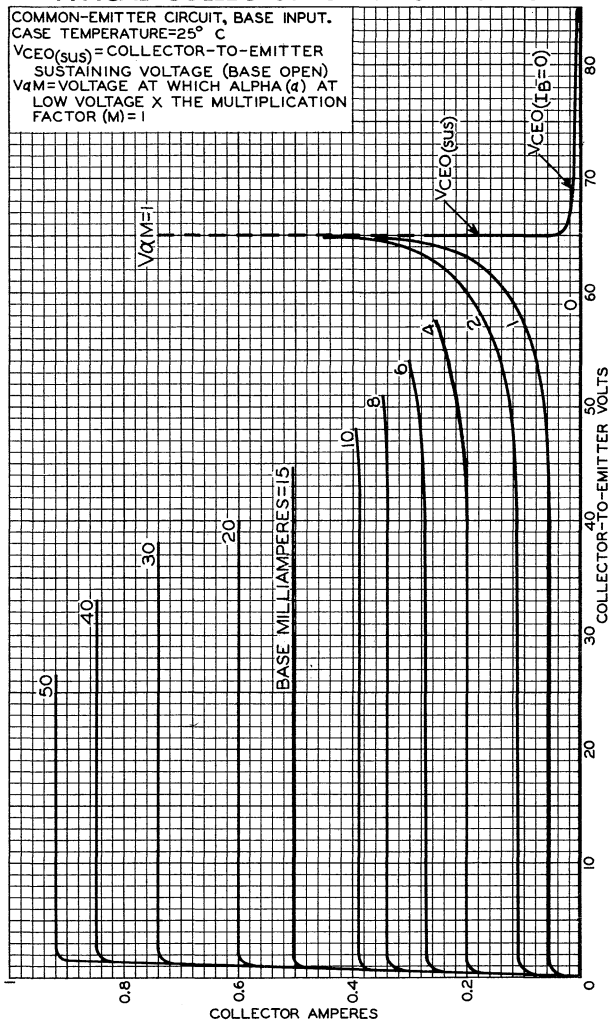
TYPICAL BASE CHARACTERISTICS



92CS-10438R1

TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
CASE TEMPERATURE=25° C
 $V_{CEO(sus)}$ = COLLECTOR-TO-EMITTER
SUSTAINING VOLTAGE (BASE OPEN)
 $V_{\alpha M}$ = VOLTAGE AT WHICH ALPHA (α) AT
LOW VOLTAGE X THE MULTIPLICATION
FACTOR (M) = 1



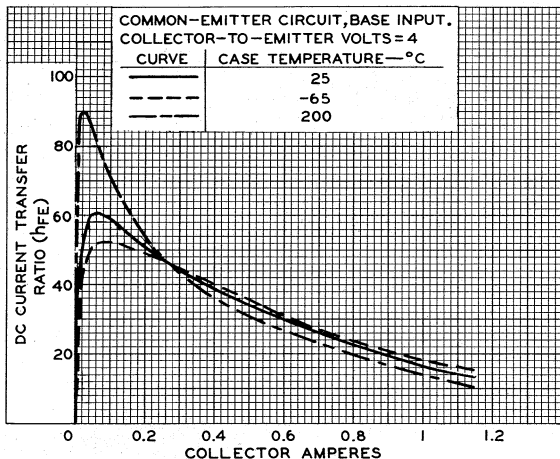
92CM-10453



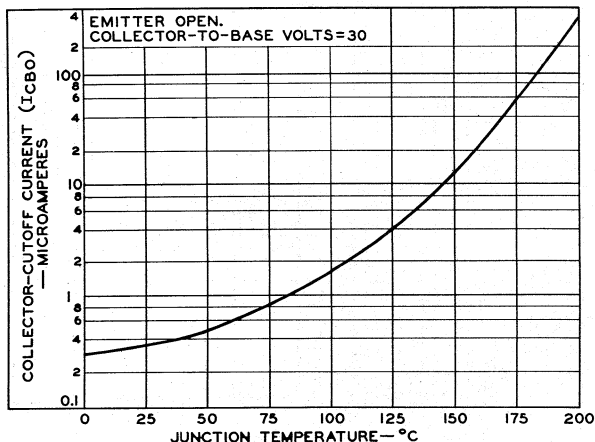
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Semiconductor & Materials Division
Somerville, N. J.

DATA 4
6-61

TYPICAL OPERATION CHARACTERISTICS



92CS-10450RI



92CS-10881



Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Medium-Power Switching and Amplifier Ser-
vice in Industrial and Military Applications

The 2N1480 is the same as the 2N1479 except for the following items:

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, relay- and solenoid-actuating circuits

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	100 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With emitter-to-base reverse biased		
(DC emitter-to-base volts = 1.5)	100 max.	volts
With base open (Sustaining voltage) [■]	55 max.	volts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Collector-to-Emitter Voltage:			
With emitter reverse bias			
volts = 1.5, dc collector			
ma. = 0.25 V_{CEX}	100	-	volts
With base open (Sustaining			
voltage), dc collector			
ma. = 50, dc base ma. = 0 $V_{CEO}^{\square}$	55	-	volts
	(sus)		

- [■] The Collector-to-Emitter Sustaining Voltage ($V_{CEO(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{\alpha M} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).



Power Transistor

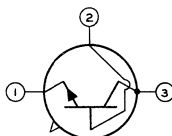
SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-5
Case.	Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, relay- and solenoid-actuating circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	60 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With emitter-to-base reverse biased		
(DC emitter-to-base volts = 1.5).	60 max.	volts
With base open (Sustaining voltage) ^a	40 max.	volts
EMITTER-TO-BASE VOLTAGE	12 max.	volts
COLLECTOR CURRENT	1.5 max.	amp
EMITTER CURRENT	-1.75 max.	amp
BASE CURRENT.	1 max.	amp
TRANSISTOR DISSIPATION: ^b		
At case temperature of 25° C.	5 max.	watts
At case temperature of 100° C.	2.86 max.	watts
CASE-TEMPERATURE RANGE: ^c		
Operating and storage	-65 to +200	°C

Characteristics:

At case temperature of 25° C

Small-Signal Current Transfer Ratio (h_{fe})
with dc collector-to-emitter volts

= 4, dc collector ma. = 5 50

← Indicates a change.



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DATA 1
6-61

Alpha-Cutoff Frequency (f_{ab}) with dc collector-to-base volts = 28, dc collector ma. = 5.	1.5	Mc
Collector-to-Base Capacitance (C_{ob}) with dc collector-to-base volts = 40.	150	$\mu\mu\text{f}$
Thermal Time Constant (τ_1).	10	msec

Typical Operation:

*In accompanying typical power-switching
circuit at case temperature of 25° C*

DC Supply Voltage (B_2).	12	volts
DC Base-Bias Voltage (B_1).	-8.5	volts
"On" DC Collector Current	200	ma
"Turn-On" Base Current (I_{B1}).	20	ma
"Turn-Off" Base Current (I_{B2}).	-8.5	ma
Generator Resistance.	50	ohms
Switching Time:		
Delay time (t_d).	0.2	μsec
Rise time (t_r).	1	μsec
Storage time (t_s).	0.6	μsec
Fall time (t_f).	1	μsec

^a The Collector-to-Emitter Sustaining Voltage ($V_{CE0(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{\alpha M} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^b See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

^c Measured at center of seating surface.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

*Voltage values are given with respect to base and
case temperature of 25° C unless otherwise specified*

Min. Max.

Collector-to-Emitter Voltage:

With emitter reverse bias
volts = 1.5, dc collector
ma. = 0.25. V_{CEX} 60 - volts

With base open (Sustaining
voltage), dc collector
ma. = 50, dc base ma. = 0. V_{CE0}^a 40 - volts
(sus)

Base-to-Emitter Voltage for dc
collector-to-emitter volts
= 4, dc collector ma. = 200. V_{BE} - 3 volts

→ Collector-Cutoff Current I_{CBO}
for dc collector volts = 30,
dc emitter ma. = 0, case
temperature =
25° C. - 10 μa
150° C. - 500 μa

Emitter-Cutoff Current for
dc emitter volts = 12, dc
collector ma. = 0. I_{EBO} - 10 μa

→ Indicates a change.



DC Current Transfer Ratio for
dc collector-to-emitter
volts = 4, dc collector

ma. = 200 h_{FE} 35 100

DC Collector-to-Emitter

Saturation Resistance for

dc collector ma. = 200, dc

base ma. = 10 R_S - 7 ohms

Thermal Resistance:

Junction-to-case. R_T - 35 °C/watt ←

Junction-to-free air. - 200 °C/watt

- ^a The Collector-to-Emitter Sustaining Voltage ($V_{CE(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{\alpha M} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

**OPERATING CONSIDERATIONS,
TYPICAL POWER-SWITCHING CIRCUIT,
DIMENSIONAL OUTLINE,
RATING CHART,
and CURVES**

shown under Type 2N1479 also apply to the 2N1481

← Indicates a change.



RADIO CORPORATION OF AMERICA
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DATA 2
6-61

Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Medium-Power Switching and Amplifier Service in Industrial and Military Applications

The 2N1482 is the same as the 2N1481 except for the following items:

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, relay- and solenoid-actuating circuits

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	100 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE: With emitter-to-base reverse biased (DC emitter-to-base volts = 1.5)	100 max.	volts
With base open (Sustaining voltage) ■ . . .	55 max.	volts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

		Min.	Max.	
Collector-to-Emitter Voltage: With emitter reverse bias volts = 1.5, dc collector ma. = 0.25	V_{CEX}	100	-	volts
With base open (Sustaining voltage), dc collector ma. = 50, dc base ma. = 0	$V_{CEO}^{\blacksquare}$ (sus)	55	-	volts

- The Collector-to-Emitter Sustaining Voltage ($V_{CEQ(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).



Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE

For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

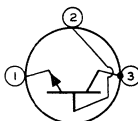
Mechanical:

Operating Position.	Any
Maximum Overall Length.	0.770"
Maximum Seated Length.	0.330"
Maximum Diameter.	0.650"
Dimensional Outline.	JEDEC No. TO-8
Case.	Metal
Seals.	Hermetic
Terminal Diagram:	

BOTTOM VIEW

Pin 1 - Emitter

Pin 2 - Base

Pin 3 - Collector,
Case

INDUSTRIAL SERVICE

*Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and servo-
amplifier, relay- and solenoid-actuating circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	60 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With emitter-to-base reverse biased		
(DC emitter-to-base volts = 1.5).	60 max.	volts
With base open (Sustaining voltage) ^a	40 max.	volts
EMITTER-TO-BASE VOLTAGE	12 max.	volts
COLLECTOR CURRENT	3 max.	amp
EMITTER CURRENT	-3.5 max.	amp
BASE CURRENT.	1.5 max.	amp
TRANSISTOR DISSIPATION: ^b		
At case temperature of 25° C.	25 max.	watts
At case temperature of 100° C.	14.1 max.	watts
CASE-TEMPERATURE RANGE: ^c		
Operating and storage	-65 to +200	°C

Characteristics:

At case temperature of 25° C^c

Alpha-Cutoff Frequency (f_{ab}) with dc collector-to-base volts = 28, dc collector ma. = 5	1.25	Mc
--	------	----

← Indicates a change.



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Somerville, N. J.

DATA 1
6-61

Collector-to-Base Capacitance (C_{ob})		
with dc collector-to-base volts = 40.	175	$\mu\mu\text{f}$
Thermal Time Constant (τ_1).	10	msec

Typical Operation:

In accompanying typical power-switching circuit at case temperature^c of 25° C

DC Supply Voltage (B_2).	12	volts
DC Base-Bias Voltage (B_1)	-8.5	volts
"On" DC Collector Current	750	ma
"Turn-On" Base Current (I_{B1}).	65	ma
"Turn-Off" Base Current (I_{B2})	-35	ma
Generator Resistance.	50	ohms

Switching Time:

Delay time (t_d)	0.2	μsec
Rise time (t_r).	1	μsec
Storage time (t_s)	0.8	μsec
Fall time (t_f).	1.1	μsec

^a The collector-to-Emitter Sustaining voltage ($V_{CEQ(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{\alpha M} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^b See accompanying Rating Chart and also Transistor-Dissipation Rating Chart in General Section.

^c Measured at center of seating surface.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base and case temperature^c of 25° C unless otherwise specified

Min. Max.

Collector-to-Emitter Voltage:

With emitter reverse bias
volts = 1.5, dc collector
ma. = 0.25. V_{CEX} 60 - volts

With base open (Sustaining
voltage), dc collector
ma. = 100, dc base ma. = 0. V_{CEO}^a 40 - volts

Base-to-Emitter Voltage for
dc collector-to-emitter
volts = 4, dc collector
ma. = 750 V_{BE} - 3.5 volts

→ Collector-Cutoff Current
for dc collector volts = 30,
dc emitter ma. = 0, case
temperature =
25° C - 15 μa
150° C. - 750 μa

Emitter-Cutoff Current for
dc emitter volts = 12, dc
emitter ma. = 0 I_{EBO} - 15 μa

→ DC Current Transfer Ratio for
dc collector-to-emitter volts
= 4, dc collector ma. = 750 . . . h_{FE} 20 60

→ Indicates a change.



DC Collector-to-Emitter

Saturation Resistance for
dc collector ma. = 750, dc

base ma. = 75 R_S - 2.67 ohms

Thermal Resistance:

Junction-to-case. R_T - 7 °C/watt ←

Junction-to-free air. - 100 °C/watt

a The Collector-to-Emitter Sustaining Voltage ($V_{CEQ(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

c Measured at center of seating surface.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connection can be made to the collector, base, and emitter pins by means of clips or by soldering directly to the pins. Soldering of connections to the pins may be made close to the pin seals provided care is taken to conduct excessive heat away from the pin seal, otherwise the heat of the soldering operation will crack the glass seals of the pins and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using this transistor, the temperature of the solder should not exceed 235° C for a maximum immersion period of 10 seconds. Furthermore, the pins should not be dip soldered closer than 1/32" from the transistor case.

Under no circumstances should the case be soldered to the heat sink because the heat of the soldering operation will permanently damage the transistor.

It is important that this transistor be securely fastened to a heat sink. Amounting clamp is provided for this purpose.

The chassis (heat sink) may be connected either to the positive or negative terminal of the voltage supply. In applications where the chassis is connected to the negative terminal of the voltage supply, it will be necessary to use an anodized-aluminum insulator having high thermal conductivity, or a 0.002" mica insulator between the transistor case and the chassis. The insulator should extend beyond the mounting clamp (See *Suggested Mounting Arrangement*). An aluminum washer should be drilled or punched to provide the two mounting holes, and the clearance holes for the collector, emitter, and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting,

← Indicates a change.

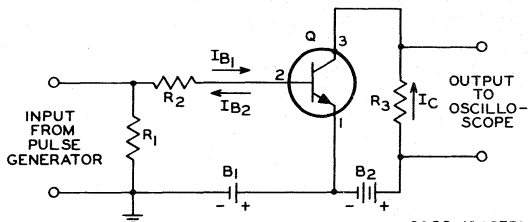


2N1483

it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolt and the chassis, it is important that an insulating washer be used between the bolt and the chassis.

It is to be noted that the case of this transistor operates at the collector voltage. Consideration therefore, should be given to the possibility of shock hazard if the case of this transistor is to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

TYPICAL POWER-SWITCHING CIRCUIT



92CS-10427R1

B_1 : 8.5 volts

B_2 : 12 volts

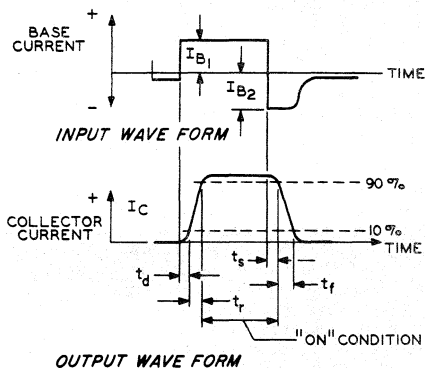
Q: Transistor type 2N1483

R_1 : 50 ohms, 1 watt

R_2 : 220 ohms, 1 watt

R_3 : 15.9 ohms, 2 watts

ASSOCIATED WAVE FORMS

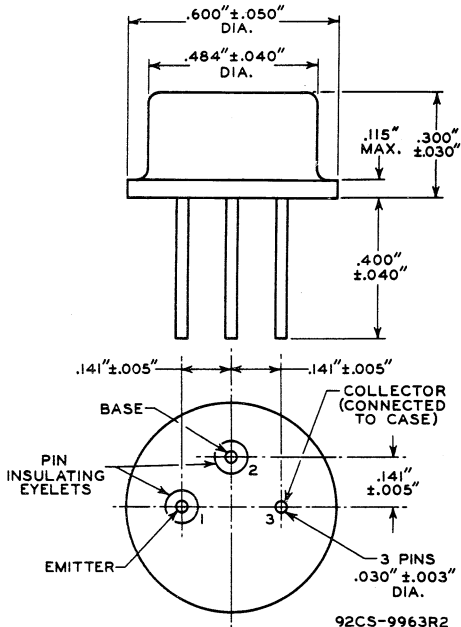


92CS-10029

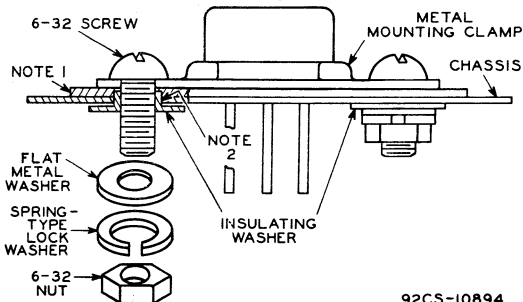
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JEDEC No. T0-8



SUGGESTED MOUNTING ARRANGEMENT



NOTE 1: 0.002" MICA INSULATOR OR ANODIZED ALUMINUM INSULATOR (DRILLED, OR PUNCHED WITH BURRS REMOVED).

NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.

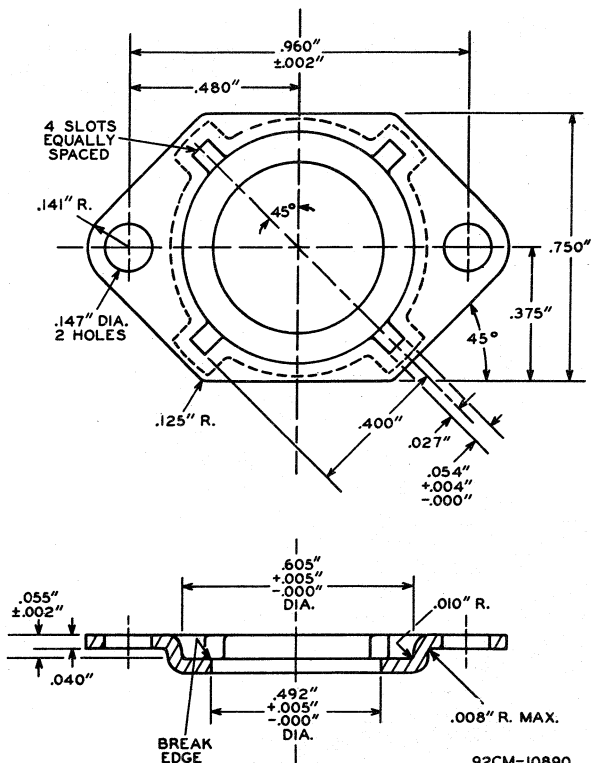


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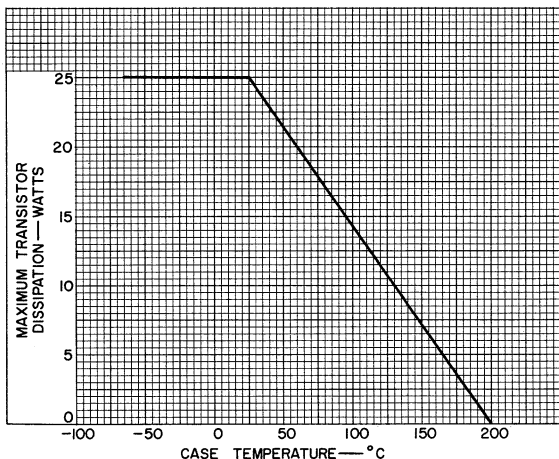
DATA 3
6-61

MOUNTING CLAMP

Supplied with Each Transistor

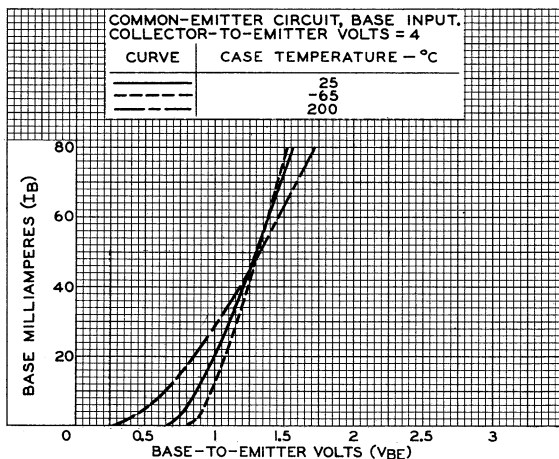


RATING CHART



92CS-10442R2

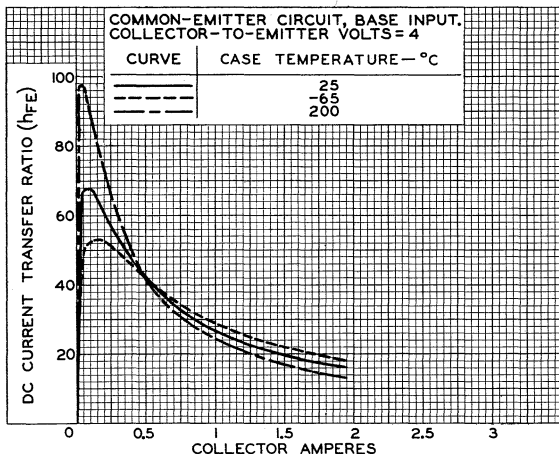
TYPICAL BASE CHARACTERISTICS



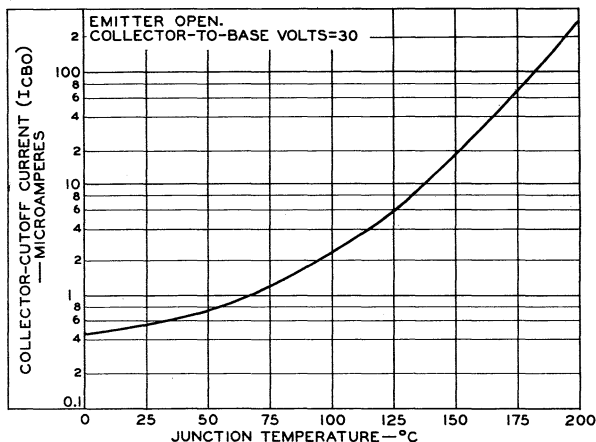
92CS-10443R3



TYPICAL OPERATION CHARACTERISTICS



92CS-10444R2



92CS-10882



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DATA 5
6-61

Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE

For Intermediate-Power Switching and Amplifier
Service in Industrial and Military Applications

The 2N1484 is the same as the 2N1483 except for the following items:

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, relay- and solenoid-actuating circuits

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	100 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With emitter-to-base reverse biased		
(DC emitter-to-base volts = 1.5) . . .	100 max.	volts
With base open (Sustaining voltage)■ . .	55 max.	volts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

		Min.	Max.	
Collector-to-Emitter Voltage:				
With emitter reverse bias				
volts = 1.5, dc collector				
ma. = 0.25	V_{CEX}	100	-	volts
With base open (Sustaining				
voltage), dc collector				
ma. = 100, dc base				
ma. = 0	$V_{CEO}^{\square}$ (sus)	55	-	volts

- The Collector-to-Emitter Sustaining Voltage ($V_{CEO(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{\alpha M} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).



Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Power Switching and Amplifier Service
in Industrial and Military Applications

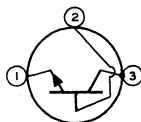
GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Overall Length.	0.770"
Maximum Seated Length.	0.330"
Maximum Diameter.	0.650"
Dimensional Outline.	JEDEC No. TO-8
Case.	Metal
Seals.	Hermetic
Terminal Diagram:	

BOTTOM VIEW

Pin 1—Emitter
Pin 2—Base



Pin 3—Collector,
Case

INDUSTRIAL SERVICE

*Such as dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and servo-
amplifier, relay- and solenoid-actuating circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE.	60 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE: With emitter-to-base reverse biased (DC emitter-to-base volts = 1.5).	60 max.	volts
With base open (Sustaining voltage) ^a	40 max.	volts
EMITTER-TO-BASE VOLTAGE.	12 max.	volts
COLLECTOR CURRENT.	3 max.	amp
EMITTER CURRENT.	-3.5 max.	amp
BASE CURRENT.	1.5 max.	amp
TRANSISTOR DISSIPATION: ^b At case temperature of 25° C.	25 max.	watts
At case temperature of 100° C.	14.1 max.	watts
CASE TEMPERATURE RANGE: ^c Operating and storage.	-65 to +200	°C

Characteristics:

At case temperature of 25° C^c

Alpha-Cutoff Frequency (f_{ab}) with dc collector-to-base volts = 28, dc collector ma. = 5.	1.25	Mc
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←Indicates a change.



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DATA 1
6-61

Collector-to-Base Capacitance (C_{ob})		
with dc collector-to-base volts = 40.	175	$\mu\mu f$
Thermal Time Constant (τ_1).	10	msec

Typical Operation:

In accompanying typical power-switching circuit at case temperature^c of 25° C

DC Supply Voltage (B_2).	12	volts
DC Base-Bias Voltage (B_1)	-8.5	volts
"On" DC Collector Current	750	ma
"Turn-On" Base Current (I_{B1}).	65	ma
"Turn-Off" Base Current (I_{B2})	-35	ma
Generator Resistance.	50	ohms
Switching Time:		
Delay time (t_d)	0.2	μsec
Rise time (t_r)	1	μsec
Storage time (t_s)	0.8	μsec
Fall time (t_f)	1.1	μsec

^a The Collector-to-Emitter Sustaining Voltage ($V_{CE0(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{\alpha M} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^b See accompanying Rating Chart and also Transistor-Dissipation Rating Chart in General Section.

^c Measured at center of seating surface.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base and case temperature^c of 25° C unless otherwise specified

		Min.	Max.	
Collector-to-Emitter Voltage:				
With emitter reverse bias				
volts = 1.5, dc collector				
ma. = 0.25.	V_{CEX}	60	-	volts
With base open (Sustaining				
voltage), dc collector				
ma. = 100, dc base				
ma. = 0	V_{CE0}^a (sus)	40	-	volts
Base-to-Emitter Voltage				
for dc collector-to-emitter				
volts = 4, dc collector				
ma. = 750	V_{BE}	-	2.5	volts
→ Collector-Cutoff Current	I_{CBO}			
for dc collector volts				
= 30, dc emitter ma. = 0,				
case temperature =				
25° C		-	15	μa
150° C.		-	750	μa
Emitter-Cutoff Current for				
dc emitter volts = 12,				
dc emitter ma. = 0.	I_{EBO}	-	15	μa

→ Indicates a change.



DC Current Transfer Ratio
for dc collector-to-emitter
volts = 4, dc collector ma.
= 750.

h_{FE} 35 100

DC Collector-to-Emitter
Saturation Resistance for
dc collector ma. = 750, dc
base ma. = 40.

R_S - 1 ohm
 R_T

Thermal Resistance:

Junction-to-case 7 °C/watt

Junction-to-free air 100 °C/watt

^a The Collector-to-Emitter Sustaining Voltage ($V_{CE0(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^c Measured at center of seating surface.

OPERATING CONSIDERATIONS,
TYPICAL POWER-SWITCHING CIRCUIT,
DIMENSIONAL OUTLINE,
RATING CHART,
and CURVES

shown under Type 2N1483 also apply to the 2N1485

← Indicates a change.



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DATA 2
6-61

Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE
 For Intermediate-Power Switching and Amplifier
 Service in Industrial and Military Applications

The 2N1486 is the same as the 2N1485 except for the following items:

INDUSTRIAL SERVICE

Such as dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, relay- and solenoid-actuating circuits

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE.	100 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With emitter-to-base reverse biased		
(DC emitter-to-base volts = 1.5)	100 max.	volts
With base open (Sustaining voltage)■ . .	55 max.	volts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

		Min.	Max.	
Collector-to-Emitter Voltage:				
With emitter reverse bias				
volts = 1.5, dc collector				
ma. = 0.25.	V_{CEX}	100	-	volts
With base open (Sustaining				
voltage), dc collector				
ma. = 100, dc base				
ma. = 0	$V_{CE0}^{\square}$	55	-	volts
	(sus)			

- The Collector-to-Emitter Sustaining Voltage ($V_{CE0}(\text{sus})$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).



Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Power Switching and Amplifier Service
in Industrial and Military Applications

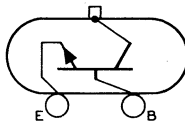
GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Overall Length.	0.865"
Maximum Seated Length.	0.390"
Maximum Length of Mounting Flange.	1.550"
Maximum Width of Mounting Flange.	1.015"
Case.	Metal
Mounting Flange.	Metal
Seals.	Hermetic
Socket.	Loranger Mfg. Corp. No.2149, or equivalent
Terminal Diagram (See <i>Dimensional Outline</i>):	

E - Emitter

B - Base



MOUNTING FLANGE-
Collector,
Case

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper,
voltage- and current-regulator, dc- and servo-
amplifier, relay- and solenoid-actuating circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE.	60 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With emitter-to-base reverse biased (DC emitter-to-base volts = 1.5)	60 max.	volts
With base open (Sustaining voltage) ^a	40 max.	volts
EMITTER-TO-BASE VOLTAGE.	10 max.	volts
COLLECTOR CURRENT.	6 max.	amp
EMITTER CURRENT.	-8 max.	amp
BASE CURRENT.	3 max.	amp
TRANSISTOR DISSIPATION: ^b		
At mounting-flange temperature of 25° C.	75 max.	watts
At mounting-flange temperature of 100° C.	43 max.	watts
MOUNTING-FLANGE TEMPERATURE RANGE: ^c		
Operating and storage.	-65 to +200	°C

Characteristics:

At mounting-flange temperature of 25° C^c

Alpha-Cutoff Frequency (f_{ab})

with dc collector-to-base volts

= 12, dc collector ma. = 100 1 Mc

← Indicates a change.



RADIO CORPORATION OF AMERICA
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Somerville, N. J.

DATA 1
6-61

Collector-to-Base Capacitance (C_{ob})		
with dc collector-to-base volts = 40	200	μf
Thermal Time Constant (τ_1)	12	msec

Typical Operation:

In accompanying typical power-switching circuit at mounting-flange temperature^c of 25° C

DC Supply Voltage (B_2)	12	volts
DC Base-Bias Voltage (B_1)	-8.5	volts
"On" DC Collector Current	1.5	amp
"Turn-On" Base Current (I_{B1})	0.3	amp
"Turn-Off" Base Current (I_{B2})	-0.15	amp
Generator Resistance	50	ohms
Switching Time:		
Delay Time (t_d)	0.2	μsec
Rise Time (t_r)	1	μsec
Storage Time (t_s)	1	μsec
Fall Time (t_f)	1.2	μsec

^a The Collector-to-Emitter Sustaining Voltage ($V_{CE0(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($\alpha_M = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^b See accompanying Rating Chart and also Transistor-Dissipation Rating Chart in General Section.

^c Measured at center of seating surface.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base and mounting-flange temperature^c of 25° C unless otherwise specified

Min. Max.

Collector-to-Emitter Voltage:

With emitter reverse bias

volts = 1.5, dc collector

ma. = 0.5 V_{CEX} 60 - volts

With base open (Sustaining voltage), dc collector

ma. = 100, dc base ma. = 0 V_{CE0}^a 40 - volts

Base-to-Emitter Voltage for

dc collector-to-emitter volts

= 4, dc collector amperes = 1.5 V_{BE} - 3.5 volts

→ Collector-Cutoff Current I_{CBO}

for dc collector volts =

30, dc emitter ma. = 0,

mounting-flange temperature =

25° C - 25 μa

150° C - 1000 μa

Emitter-Cutoff Current for dc

emitter volts = 10, dc

collector ma. = 0 I_{EBO} - 25 μa

→ DC Current Transfer Ratio

for dc collector-to-emitter

volts = 4, dc collector

amperes = 1.5 h_{FE} 15 45

→ Indicates a change.



DC Collector-to-Emitter

Saturation Resistance for

dc collector amperes = 1.5,

dc base ma. = 300. R_S - 2 ohms

Thermal Resistance:

Junction-to-mounting-flange. R_T - 2.33 °C/watt

a The collector-to-emitter Sustaining Voltage ($V_{CE0(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

c Measured at center of seating surface.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

This transistor utilizes the Loranger Mfg. Corp. socket No. 2149, or equivalent. Electrical connection can also be made to the base and emitter pins by soldering directly to the pins. Soldering of connections to the pins may be made close to the pin seals provided care is taken to conduct excessive heat away from the pin seal, otherwise the heat of the soldering operation will crack the glass seals of the pins and damage the transistor.

Under no circumstances should the mounting flange be soldered to the heat sink because the heat of the soldering operation will permanently damage the transistor.

It is important that the mounting flange which serves as the collector terminal be securely fastened to a heat sink. Depending on the application, the chassis (heat sink) may be connected either to the positive or negative terminal of the voltage supply.

In applications where the chassis is connected to the negative terminal of the voltage supply, it will be necessary to use an anodized-aluminum insulator having high thermal conductivity, or a 0.002" mica insulator between the mounting flange and the chassis. An aluminum washer should be drilled or punched to provide the two mounting holes, and the clearance holes for the emitter and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolt and the chassis, it is important that an insulating washer be used between the bolt and the chassis (See *Suggested Mounting Arrangement*).

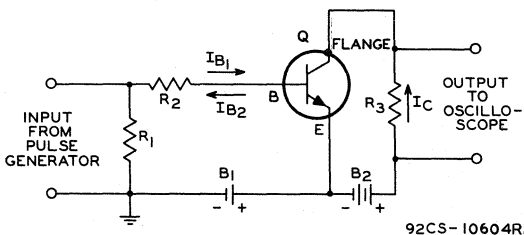
It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

← Indicates a change.



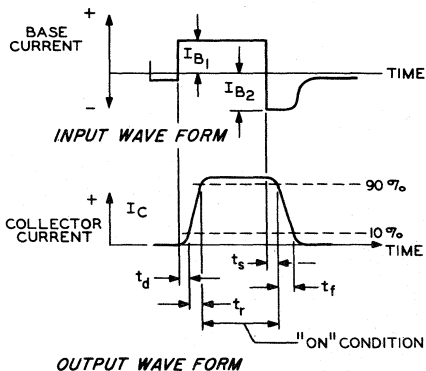
2N1487

TYPICAL POWER-SWITCHING CIRCUIT



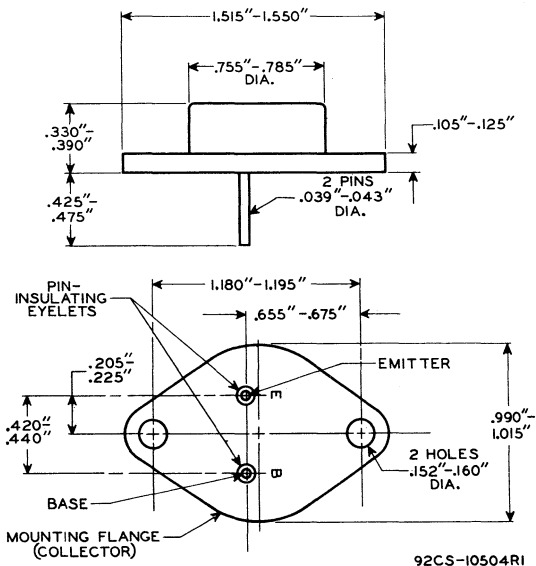
$B_1 = 8.5$ volts
 $B_2 = 12$ volts
 $Q =$ Transistor type 2N1487
 $R_1 = 50$ ohms, 1 watt
 $R_2 = 30$ ohms, 1 watt
 $R_3 = 7.8$ ohms, 2 watts

ASSOCIATED WAVE FORMS

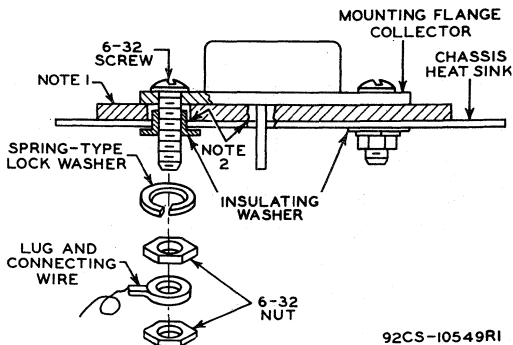


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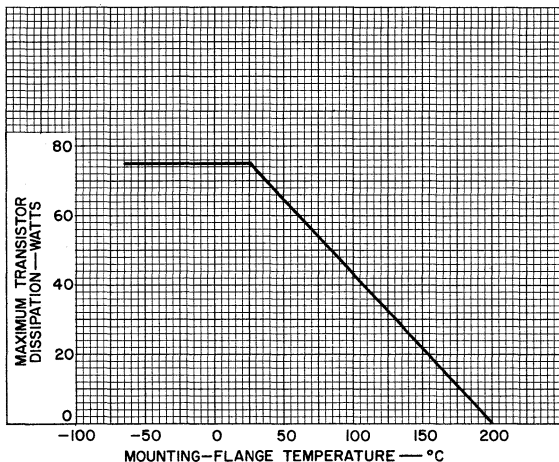
SUGGESTED MOUNTING ARRANGEMENT



NOTE 1: 0.002" MICA INSULATOR OR ANODIZED-ALUMINUM INSULATOR (DRILLED, OR PUNCHED WITH BURRS REMOVED).

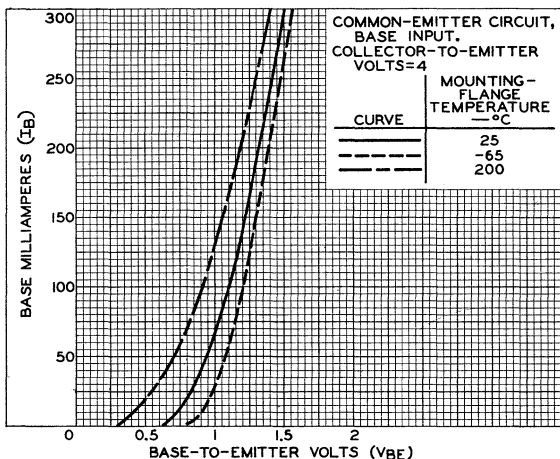
NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.

RATING CHART



92CS-11088

TYPICAL BASE CHARACTERISTICS



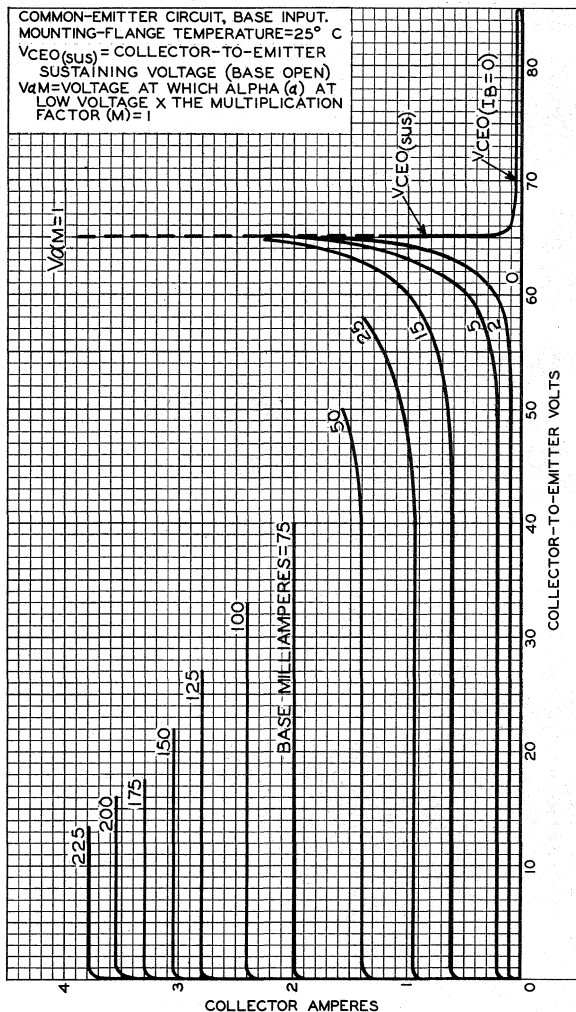
92CS-10451R2



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Somerville, N. J.

DATA 4
6-61

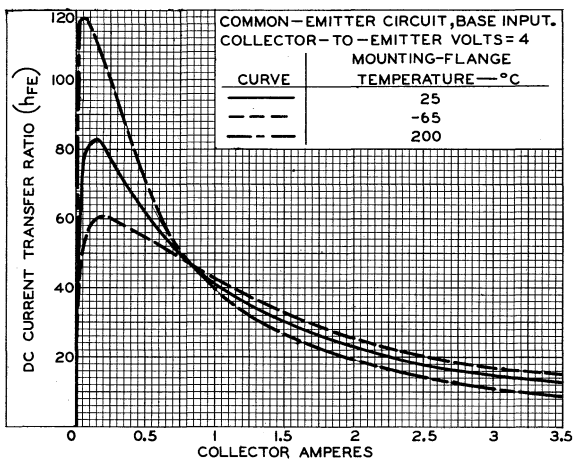
TYPICAL COLLECTOR CHARACTERISTICS



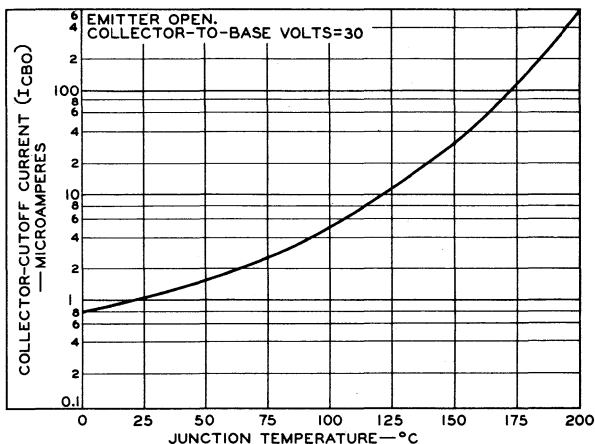
92CM-10447



TYPICAL OPERATION CHARACTERISTICS



92CS-10454RI



92CS-10883



Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE
For High-Power Switching and Amplifier Service in Industrial and Military Applications

The 2N1488 is the same as the 2N1487 except for the following items:

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, relay- and solenoid-actuating circuits

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE.	100 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With emitter-to-base reverse biased		
(DC emitter-to-base volts = 1.5)	100 max.	volts
With base open (Sustaining voltage) ■	55 max.	volts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max	
Collector-to-Emitter Voltage:			
With emitter reverse bias			
volts = 1.5, dc collector			
ma. = 0.5 V_{CEX}	100	-	volts
With base open (Sustaining			
voltage), dc collector			
ma. = 100, dc base			
ma. = 0 V_{CE0} (sus)	55	-	volts

- The Collector-to-Emitter Sustaining Voltage ($V_{CE0(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).



Power Transistor

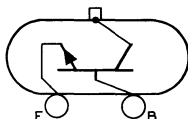
SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Power Switching and Amplifier Service
in Industrial and Military Applications

GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Overall Length.	0.865"
Maximum Seated Length.	0.390"
Maximum Length of Mounting Flange.	1.550"
Maximum Width of Mounting Flange.	1.015"
Case.	Metal
Mounting Flange.	Metal
Seals.	Hermetic
Socket.	Loranger Mfg. Corp. No.2149, or equivalent
Terminal Diagram (See <i>Dimensional Outline</i>):	

E - Emitter
 B - Base



MOUNTING FLANGE-
 Collector,
 Case

INDUSTRIAL SERVICE

*Such as in dc-to-dc converter, inverter, chopper,
 voltage- and current-regulator, dc- and servo-
 amplifier, relay- and solenoid-actuating circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE.	60 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With emitter-to-base reverse biased		
(DC emitter-to-base volts = 1.5).	60 max.	volts
With base open (Sustaining voltage) ^a	40 max.	volts
EMITTER-TO-BASE VOLTAGE.	10 max.	volts
COLLECTOR CURRENT.	6 max.	amp
EMITTER CURRENT.	-8 max.	amp
BASE CURRENT.	3 max.	amp
TRANSISTOR DISSIPATION: ^b		
At mounting-flange temperature of 25° C.	75 max.	watts
At mounting-flange temperature of 100° C.	43 max.	watts
MOUNTING-FLANGE TEMPERATURE RANGE: ^c		
Operating and storage.	-65 to +200	°C

Characteristics:

At mounting-flange temperature of 25° C^c

Alpha-Cutoff Frequency (f_{ab}) with dc collector-to-base volts = 12, dc collector ma. = 100	1	Mc
--	---	----

← Indicates a change.



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DATA 1
 6-61

Collector-to-Base Capacitance (C_{ob})		
with dc collector-to-base volts = 40.	200	μmf
Thermal Time Constant (τ_1).	12	msec

Typical Operation:

In accompanying typical power-switching circuit at mounting-flange temperature of 25° C

DC Supply Voltage (B_2).	12	volts
DC Base-Bias Voltage (B_1)	-8.5	volts
"On" DC Collector Current	1.5	amp
"Turn-On" Base Current (I_{B1}).	0.3	amp
"Turn-Off" Base Current (I_{B2})	-0.15	amp
Generator Resistance.	50	ohms
Switching Time:		
Delay Time (t_d)	0.2	μsec
Rise Time (t_r).	1	μsec
Storage Time (t_s)	1	μsec
Fall Time (t_f).	1.2	μsec

■ The Collector-to-Emitter Sustaining Voltage ($V_{CE0(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($\alpha_M = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

b See accompanying Rating Chart and also Transistor-Dissipation Rating Chart in General Section.

c Measured at center of seating surface.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Voltage values are given with respect to base and mounting-flange temperature^c of 25° C unless otherwise specified

Min. Max.

Collector-to-Emitter Voltage:

With emitter reverse bias
volts = 1.5, dc collector
ma. = 0.5. V_{CEX} 60 - volts

With base open (Sustaining
voltage), dc collector
ma. = 100, dc base
ma. = 0. $V_{CE0(sus)}^a$ 40 - volts

Base-to-Emitter Voltage

for dc collector-to-
emitter volts = 4, dc
collector amperes = 1.5. . . V_{BE} - 2.5 volts

→ Collector-Cutoff Current
for dc collector volts =
30, dc emitter ma. = 0,
mounting-flange temperature =
25° C. - 25 μa
150° C. - 1000 μa

Emitter-Cutoff Current for
dc emitter volts = 10,
dc collector ma. = 0. . . . I_{EBO} - 25 μa

→ Indicates a change.



DC Current Transfer Ratio			
for dc collector-to-emitter			
volts = 4, dc collector amperes			
= 1.5. h_{FE}			
	25	75	
DC Collector-to-Emitter			
Saturation Resistance for			
dc collector amperes = 1.5,			
dc base ma. = 100. R_S			
	-	0.67	ohms
Thermal Resistance:			
Junction-to-mounting-flange R_T			
	-	2.33	$^{\circ}\text{C}/\text{watt}$ ←

^a The Collector-to-Emitter Sustaining Voltage ($V_{CE0}(\text{sus})$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{\alpha M} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^c Measured at center of seating surface.

OPERATING CONSIDERATIONS, TYPICAL POWER SWITCHING CIRCUIT, RATING CHART, and CURVES

shown under Type 2N1487 also apply to the 2N1489

← Indicates a change.



Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE

For High-Power Switching and Amplifier Service in Industrial and Military Applications

The 2N1490 is the same as the 2N1489 except for the following items:

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, relay- and solenoid-actuating circuits

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE. 100 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With emitter-to-base reverse biased

(DC emitter-to-base volts = 1.5) 100 max. volts

With base open (Sustaining voltage)■ . . . 55 max. volts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Collector-to-Emitter Voltage:			
With emitter reverse bias			
volts = 1.5, dc collector			
ma. = 0.5	V_{CEX}	100	- volts
With base open (Sustaining			
voltage), dc collector			
ma. = 100, dc base			
ma. = 0	$V_{CEO}^{\square}$	55	- volts
	(sus)		

- The Collector-to-Emitter Sustaining Voltage ($V_{CEO(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).



Transistor

SILICON N-P-N TRIPLE-DIFFUSED TYPE

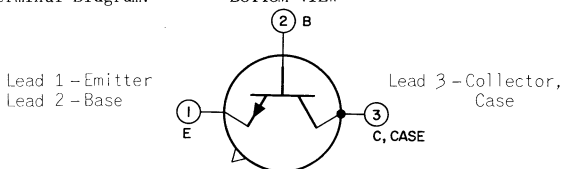
For Very-High-Frequency Amplifier and Oscillator
Applications in Industrial and Military Equipment

Mechanical:

Dimensions. See Outline TO-39 in General Section

Terminal Diagram:

BOTTOM VIEW



INDUSTRIAL SERVICE

*Such as large-signal power-amplifier,
video-amplifier, and oscillator circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage. . . V_{CBO}	30 max.	volts
With emitter open		
Collector-to-Emitter Voltage. V_{CEX}	30 max.	volts
With reverse bias		
$V_{EB} = 0.5$ volt		
Emitter-to-Base Voltage. . . V_{EBO}	1 max.	volt
With collector open		
Collector Current. I_C	250 max.	ma
Emitter Current. I_E	-250 max.	ma

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C P_T	3 max.	watts
Above 25° C. P_T	Derate linearly 0.02 watt/ $^{\circ}$ C	

At free-air temperatures:

From -65° to 25° C. P_T	0.5 max.	watt
Above 25° C. P_T	Derate linearly 0.0033 watt/ $^{\circ}$ C	

Temperature

Operating range (case) . . . T_{opr}	-65° to 175	$^{\circ}$ C
Storage range. T_{stg}	-65° to 175	$^{\circ}$ C
Leads: ^b		
For 10 seconds maximum . . T_L	255 max.	$^{\circ}$ C

← Indicates a change.



ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C

Min. Typ. Max.

DC Collector-to-Base Break-down Voltage.	BV_{CBO}	30	-	-	volts
$I_C = 0.1 \text{ ma.}, I_E = 0$					
→ DC Emitter-to-Base Floating Potential.	V_{EBF}	-	-	0.5	volt
$V_{CB} = 30 \text{ volts}, I_E = 0$					
DC Collector-Cutoff Current	I_{CBO}	-	-	10	μa
$V_{CB} = 12 \text{ volts}, I_E = 0$					
→ DC Emitter-Cutoff Current	I_{EBO}	-	-	100	μa
$V_{EB} = 1 \text{ volt}, I_C = 0$					
→ Output Capacitance.	C_{ob}	-	-	5	pf
$f = 150 \text{ kc}, V_{CB} = 30 \text{ volts}, I_E = 0$					
Collector-to-Base + Stem Capacitance.		-	-	5	pf
$V_{CB} = 30 \text{ volts}, I_E = 0$					
Small-Signal Short-Circuit Forward-Current Transfer Ratio	h_{fe}	15	-	200	
$f = 1 \text{ kc}, V_{CE} = 20 \text{ volts}, I_C = 15 \text{ ma.}$					
→ Gain Bandwidth Product.	f_T	-	300	-	Mc
$V_{CB} = 30 \text{ volts}, I_C = 15 \text{ ma.}$					
Power Gain ^c	G_{pe}	13	-	-	db
$f = 70 \text{ Mc}, V_{CC} = 15 \text{ volts}, I_{EE} = -15 \text{ ma.}, P_o = 10 \text{ mw}$					
Thermal Resistance.	θ_{JC}	-	-	50	°C/watt
Junction-to-case					

^a Measured at center of seating plane.

^b Measured 1/16" ± 1/32" along lead from seating plane.

^c See accompanying *Neutralized-Amplifier Circuit*.

OPERATING CONSIDERATIONS

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

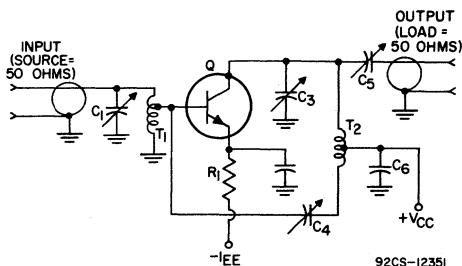
The leads of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

→ Indicates a change.



It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

NEUTRALIZED-AMPLIFIER CIRCUIT For Power Gain Measurement at 70 Mc



C_1	C_3	C_5 :	3-20 pf, variable	T_1 :	8 turns No.24 wire tapped at 1 turn, wound on a F303 toroid of Q3 Material, General Ceramics Inc.
C_2	C_6 :		0.01 μ f	T_2 :	8 turns No.24 wire tapped at 2.5 turns, wound on a 3/8" dia. ceramic coil form, no core, General Ceramics Inc.
	C_4 :		7-100 pf, variable	I_{EE} :	-15 ma
	I_{EE} :		-15 ma	Q:	Transistor type 2N1491
	R_1 :		1000 ohms, 2 watts	V_{CC} :	15 volts

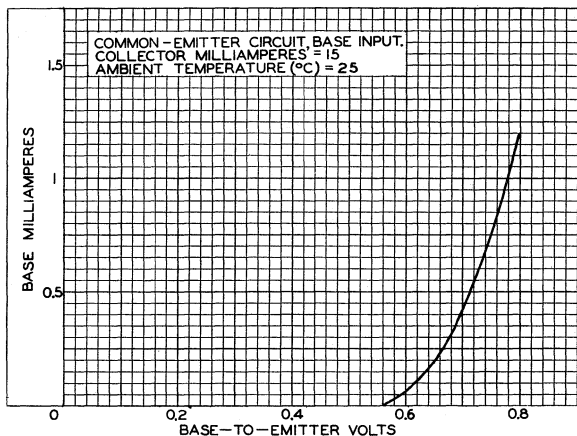
NEUTRALIZATION PROCEDURE:

(a) Connect a 70-Mc signal generator (with $Z_{out} = 50$ ohms) to the input terminals of the amplifier. (b) Connect a 50-ohm r-f voltmeter across the output terminals of the amplifier. (c) Apply V_{EE} and V_{CC} , and with the signal generator adjusted for 10 mv output, tune C_2 , C_6 , and C_7 for maximum output. (d) Interchange the connections to the signal generator and the output indicator. (e) With sufficient signal applied to the output terminals of the amplifier, adjust C_4 for a minimum indication at the input. (f) Repeat steps (a), (b), and (c) to determine if retuning is necessary.

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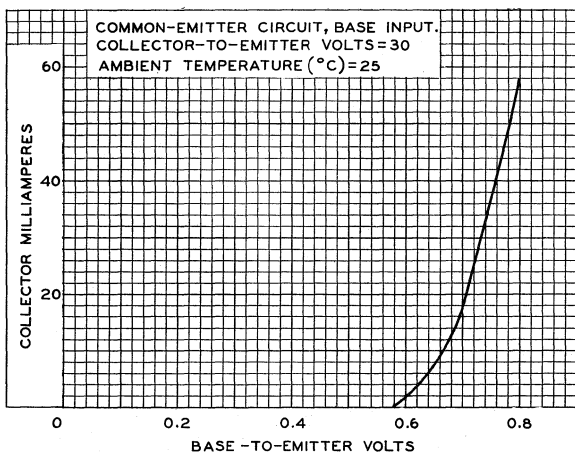


TYPICAL BASE CHARACTERISTIC



92CS-10509

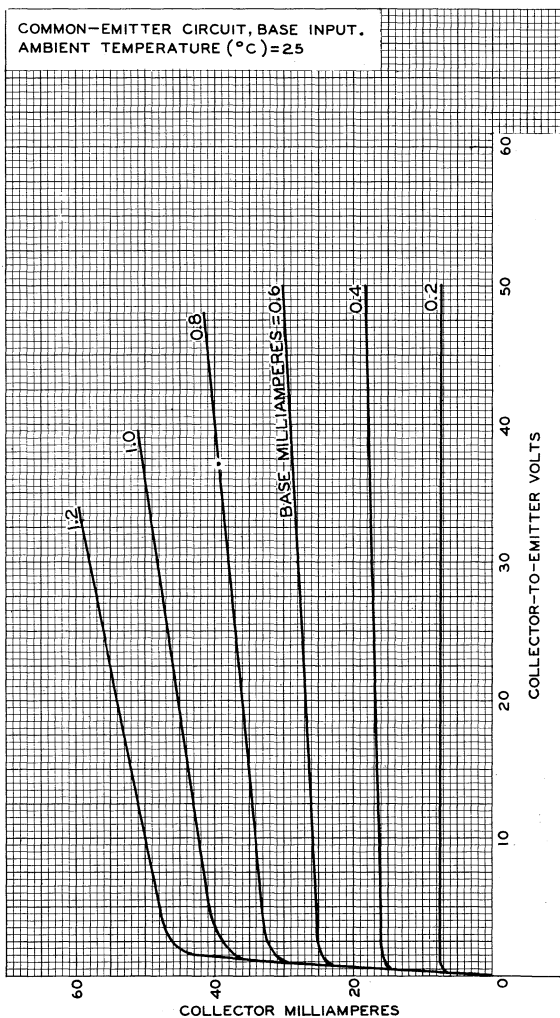
TYPICAL CHARACTERISTICS



92CS-10508

TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE ($^{\circ}\text{C}$) = 25



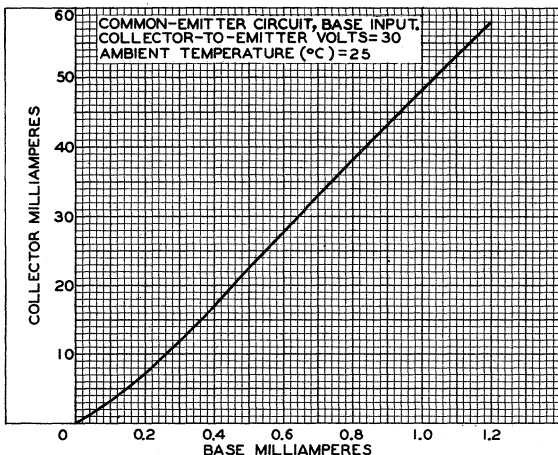
92CM-10507



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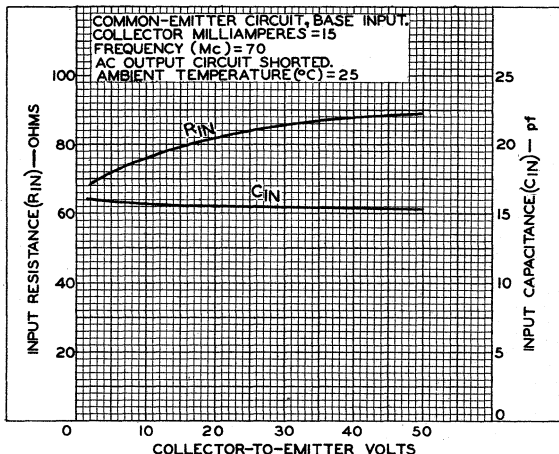
DATA 3
2-64

TYPICAL CHARACTERISTIC



92CS-10519

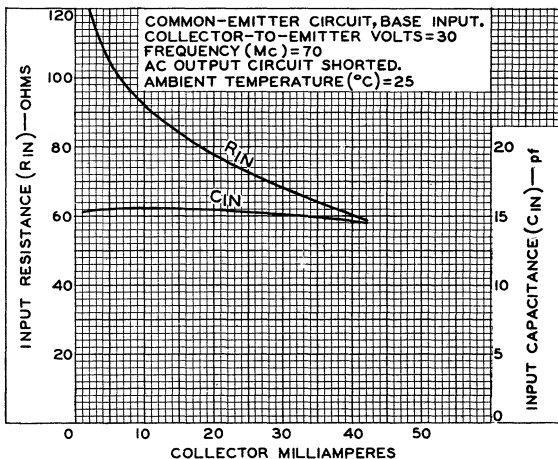
PERFORMANCE CHARACTERISTICS



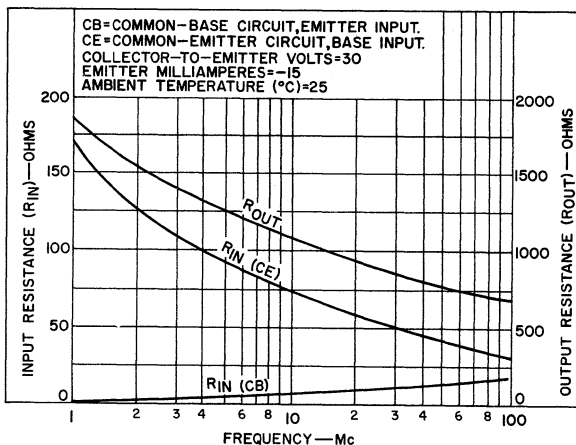
92CS-10523



PERFORMANCE CHARACTERISTICS



92CS-10521



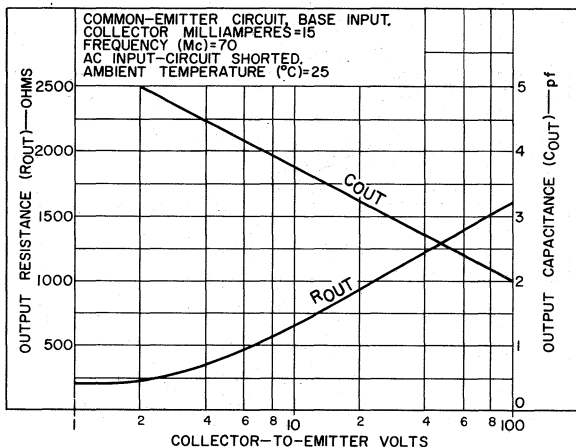
92CS-10514RI



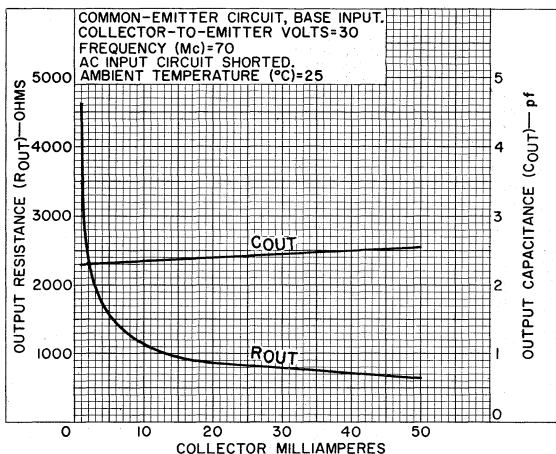
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DATA 4
2-64

PERFORMANCE CHARACTERISTICS



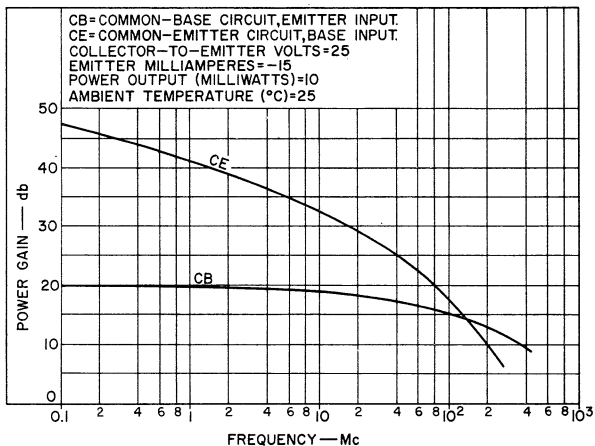
92CS-10513R2



92CS-10515R1



PERFORMANCE CHARACTERISTICS



92CS-10517RI





Transistor

SILICON N-P-N TRIPLE-DIFFUSED TYPE

For Very-High-Frequency Amplifier and Oscillator
Applications in Industrial and Military Equipment

The 2N1492 is the same as the 2N1491 except for the following items:

INDUSTRIAL SERVICE

Such as large-signal power-amplifier,
video-amplifier, and oscillator circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage.	V_{CBO}	60 max.	volts
With emitter open			
Collector-to-Emitter Voltage.	V_{CEX}	60 max.	volts ←
With reverse bias			
$V_{EB} = 0.5$ volt			
Emitter-to-Base Voltage.	V_{EBO}	2 max.	volts
With collector open			

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C

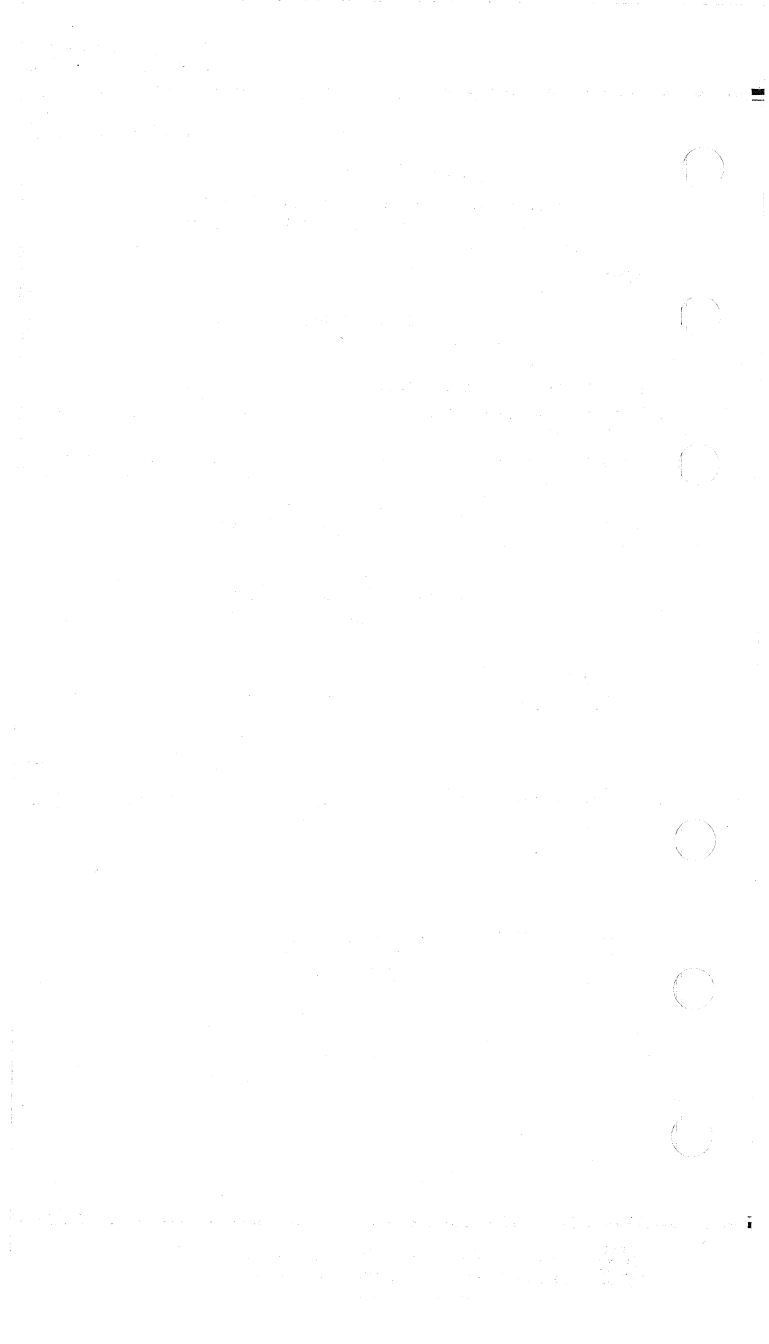
		Min.	Typ.	Max.	
DC Collector-to-Base Breakdown Voltage.	BV_{CBO}	60	-	-	volts
$I_C = 0.1$ ma., $I_E = 0$					
DC Emitter-to-Base Floating Potential.	V_{EBF}	-	-	0.5	volt ←
$V_{CB} = 60$ volts, $I_E = 0$					
DC Emitter-Cutoff Current. . .	I_{EBO}	-	-	100	μa ←
$V_{EB} = 2$ volts, $I_C = 0$					
Power Gain ^c	G_{pe}	13	-	-	db
$f = 70$ Mc, $V_{CC} = 30$ volts, $I_{EE} = -15$ ma., $P_O = 100$ mw					

^a Measured at center of seating plane.

^c See accompanying *Neutralized-Amplifier Circuit*.

← Indicates a change.





Transistor

SILICON N-P-N TRIPLE-DIFFUSED TYPE
For Very-High-Frequency Amplifier and Oscillator
Applications in Industrial and Military Equipment

The 2N1493 is the same as the 2N1491 except for the following items:

INDUSTRIAL SERVICE

*Such as large-signal power-amplifier,
video-amplifier, and oscillator circuits*

Maximum and Minimum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage	V_{CBO}	100 max.	volts
With emitter open			
Collector-to-Emitter Voltage.	V_{CEX}	100 max.	volts ←
With reverse bias $V_{EB} = 0.5$ volt			
Emitter-to-Base Voltage	V_{EBO}	4.5 max.	volts

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C

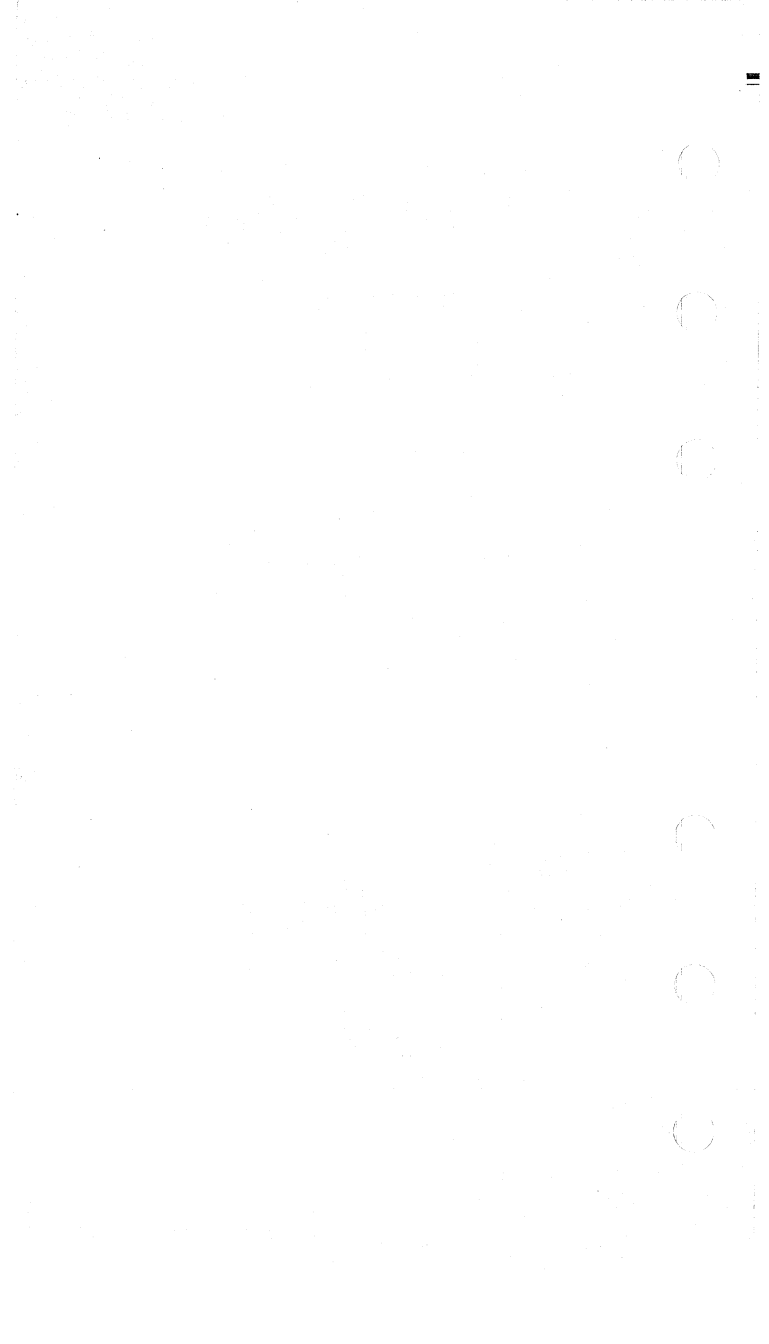
		Min.	Typ.	Max.	
DC Collector-to-Base Breakdown Voltage.	BV_{CBO}	100	-	-	volts
$I_C = 0.1$ ma., $I_E = 0$					
DC Emitter-to-Base Floating Potential	V_{EBF}	-	-	0.5	volt ←
$V_{CB} = 100$ volts, $I_E = 0$					
DC Emitter-Cutoff Current.	I_{EBO}	-	-	100	μa ←
$V_{EB} = 4.5$ volts, $I_C = 0$					
Power Gain ^c	G_{pe}	10	-	-	db
$f = 70$ Mc, $V_{CC} = 50$ volts, $I_{EE} = -25$ ma., power output = 500 mw					

^a Measured at center of seating plane.

^c See accompanying *Neutralized-Amplifier Circuit*.

← Indicates a change.





Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Intermediate-Frequency-Amplifier Applications in Battery-Operated AM Radio Receivers

GENERAL DATA

Electrical:

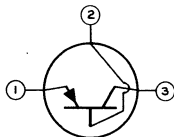
Minimum DC Collector-to-Base Voltage		
for dc emitter-to-base volts = -0.5,		
dc collector μ a = -50, ambient		
temperature = 25° C.	-24	volts
Maximum DC Collector-Cutoff Current (I_{CBO})		
for dc collector-to-base volts = -12,		
emitter open, ambient temperature = 25° C. . .	-16	μ a
Maximum DC Emitter-Cutoff Current (I_{EBO})		
for dc emitter-to-base volts = -0.5,		
collector open, ambient temperature = 25° C. .	-16	μ a
Junction-Temperature Rise (In free air).	0.4	°C/mw

Mechanical:

Operating Position	Any
Maximum Length (Excluding flexible leads).	0.410"
Maximum Diameter	0.240"
Dimensional Outline.	JEDEC No. TO-1
Case	Metal
Seals.	Hermetic
Leads, Flexible.	3
Minimum length	1.5"
Orientation and diameter	See Dimensional Outline
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector
(Adjacent
to red dot
on side of
case)

INTERMEDIATE-FREQUENCY AMPLIFIER

Maximum and Minimum Ratings, Absolute-Maximum Values:

DC COLLECTOR-TO-BASE VOLTAGE.	-24 max.	volts
DC EMITTER-TO-BASE VOLTAGE.	-0.5 max.	volt
DC COLLECTOR CURRENT.	-10 max.	ma
DC EMITTER CURRENT.	10 max.	ma
TRANSISTOR DISSIPATION:		
At ambient temperature of 25° C	80 max.	mw
At ambient temperature of 55° C	50 max.	mw
At ambient temperature of 71° C	35 max.	mw
AMBIENT TEMPERATURE (During operation). . .	71 max.	°C
STORAGE-TEMPERATURE RANGE	-65 to +85	°C



2N1524

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage	-12	volts
DC Emitter Current	1	ma
Small-Signal Current Transfer Ratio at 1 kc. . .	60	

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-12	volts
DC Emitter Current	1	ma
Small-Signal Current Transfer Ratio at 1 kc. . .	0.983	
Alpha-Cutoff Frequency	33	Mc

Typical Operation: At Ambient Temperature of 25° C:

In a common-emitter, base input, single-stage, 455-kc intermediate-frequency amplifier circuit

DC Supply Voltage	-6	-9	-12	volts
DC Collector-to-Emitter Voltage	-5.7	-8.5	-11	volts
DC Emitter Current	1	1	1	ma
Input Resistance	1300	1350	1550	ohms
Output Resistance	0.31	0.415	0.525	megohm
Collector-to-Base Capacitance (C _{ob})	2.2 [▲]	2.1 [▲]	2 [▲]	μmf
Maximum Power Gain*	51	52.4	54.4	db
Useful Power Gain:				
In neutralized circuit	33	33	33	db
In unneutralized circuit	29.7	30	30.2	db

In a common-emitter, base input, two-stage, 455-kc intermediate-frequency amplifier circuit

DC Supply Voltage	-6	-6	-9	-9	-12	-12	volts
DC Collector-to-Emitter Voltage	-5.7	-5.7	-8.5	-8.5	-11	-11	volts
DC Emitter Current	1	0.65	1	0.65	1	0.65	ma
Input Resistance	1300	2100	1350	2200	1550	2500	ohms
Output Resistance	0.31	0.49	0.415	0.65	0.525	0.82	megohm
Collector-to-Base Capacitance (C _{ob})	2.2 [▲]	2.2 [▲]	2.1 [▲]	2.1 [▲]	2 [▲]	2 [▲]	μmf
Maximum Power Gain*	50.9	51.3	52.4	52.8	54	54.3	db
Useful Power Gain:							
In neutralized circuit	31.2	30	31.2	30	31.2	30	db
In unneutralized circuit	28.1	26.6	28.2	26.7	28.3	26.8	db

▲ Maximum variation from this value is 1.4 μmf.

● Measured in a single-tuned unilateralized circuit matched to the generator and load impedance for maximum transfer of power (transformer-insertion losses not included).



OPERATING CONSIDERATIONS

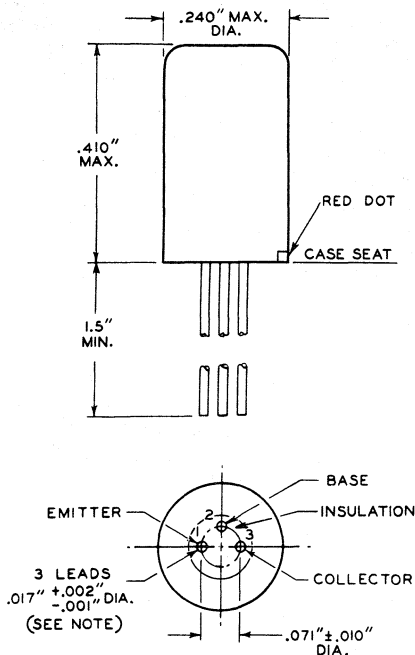
It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using this transistor, the temperature of the solder should not exceed 255°C for a maximum immersion period of 10 seconds.



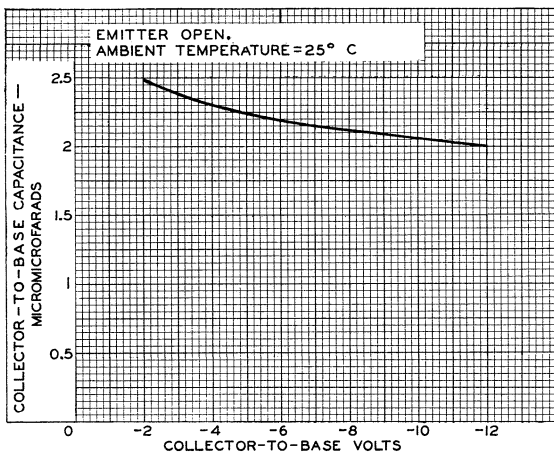
2N1524



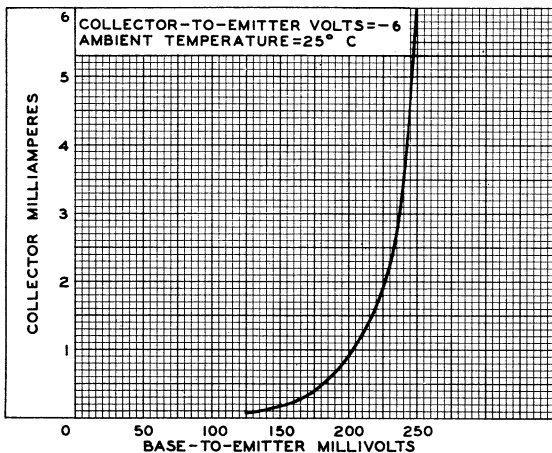
92CS-9148R6

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.05" AND 0.25" FROM THE CASE SEAT. BETWEEN 0.25" AND 1.5", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

TYPICAL CHARACTERISTICS



92CS-9820RI

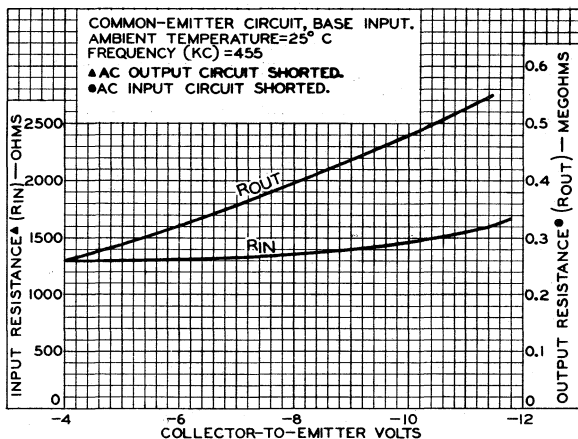


92CS-10679



2N1524

TYPICAL CHARACTERISTICS



92CS-10770



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Intermediate-Frequency-Amplifier Applications in Battery-Operated AM Radio Receivers

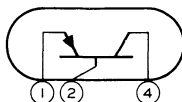
The 2N1525 is the same as the 2N1524 except for the following items:

Mechanical:

Maximum Overall Length. 0.697"
 Maximum Seated Length 0.495"
 Maximum Diameter. 0.260"
 Dimensional Outline JEDEC No. TO-40
 Case. Metal and Plastic

Terminal Diagram:

Pin 1 - Emitter
 Pin 2 - Base



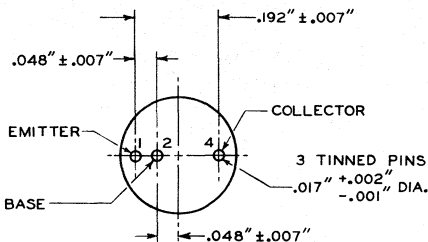
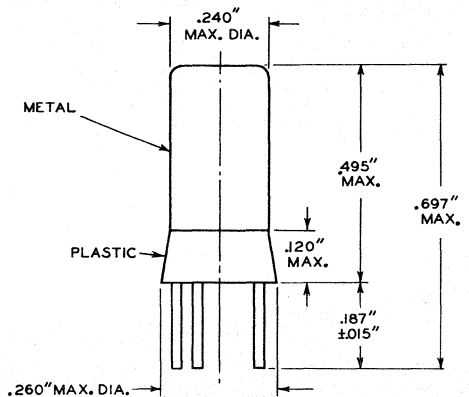
Pin 4 - Collector

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.



2N1525



PIN-SPACING TOLERANCES ARE NOT CUMULATIVE
92CS-8550R7

Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Converter Applications in
Battery-Operated AM Radio Receivers

GENERAL DATA

Electrical:

Minimum DC Collector-to-Base Voltage for dc emitter-to-base volts = -0.5, dc collector μ a = -50, ambient temperature = 25° C.	-24	volts
Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = -12, emitter open, ambient temperature = 25° C.	-16	μ a
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = -0.5, collector open, ambient temperature = 25° C.	-16	μ a
Junction-Temperature Rise (In free air).	0.4	°C/mv

Mechanical:

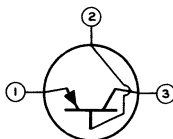
Operating Position	Any
Maximum Length (Excluding flexible leads).	0.410"
Maximum Diameter	0.240"
Dimensional Outline.	JEDEC No. TO-1
Case	Metal
Seals.	Hermetic
Leads, Flexible.	3
Minimum length	1.5"
Orientation and diameter	.See <i>Dimensional Outline</i>

Terminal Diagram:

BOTTOM VIEW

Lead 1—Emitter

Lead 2—Base

Lead 3—Collector
(Adjacent
to red dot
on side of
case)

CONVERTER

Maximum and Minimum Ratings, Absolute-Maximum Values:

DC COLLECTOR-TO-BASE VOLTAGE.	-24 max.	volts
DC EMITTER-TO-BASE VOLTAGE.	-0.5 max.	volt
DC COLLECTOR CURRENT.	-10 max.	ma
DC EMITTER CURRENT.	10 max.	ma



2N1526

TRANSISTOR DISSIPATION:

At ambient temperature of 25° C.	80 max.	mw
At ambient temperature of 55° C.	50 max.	mw
At ambient temperature of 71° C.	35 max.	mw
AMBIENT TEMPERATURE (During operation) . . .	71 max.	°C
STORAGE-TEMPERATURE RANGE.	-65 to +85	°C

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage.	-12	volts
DC Emitter Current	1	ma
Small-Signal Current Transfer Ratio at 1 kc. .	130	

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-12	volts
DC Emitter Current	1	ma
Small-Signal Current Transfer Ratio at 1 kc. .	0.992	
Alpha-Cutoff Frequency	33	Mc

Typical Operation, At Ambient Temperature of 25° C:

In a common-emitter, base input, self-excited, 1.5 Mc-converter circuit

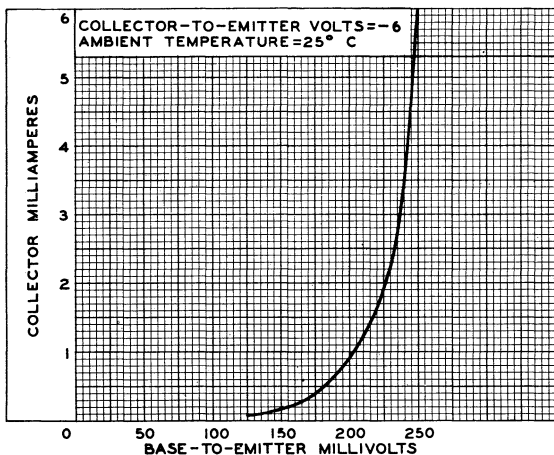
DC Supply Voltage.	-6	-9	-12	volts
DC Collector-to-Emitter Voltage.	-5	-8	-11	volts
DC Emitter Current	0.65	0.65	0.65	ma
Input Resistance	1850	1950	2150	ohms
Output Resistance.	0.19	0.28	0.48	megohm
RMS Base-to-Emitter Oscillator-Injection Voltage	100	100	100	mv
Conversion Power Gain:				
Maximum available.	44.2	46.1	48.9	db
Useful	34.2	34.5	35.8	db

OPERATING CONSIDERATIONS and DIMENSIONAL OUTLINE

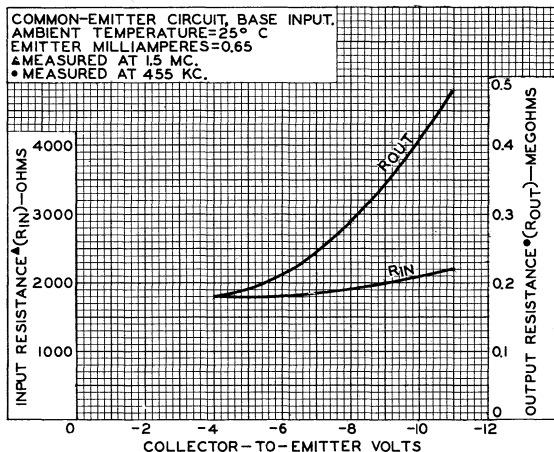
shown under Type 2N1524 also apply to the 2N1526



TYPICAL CHARACTERISTICS



92CS-10679



92CS-10583RI



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Converter Applications in
Battery-Operated AM Radio Receivers

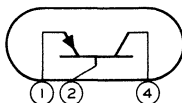
The 2N1527 is the same as the 2N1526 except for the following items:

Mechanical:

Maximum Length.	0.697"
Maximum Seated Length	0.495"
Maximum Diameter.	0.260"
Dimensional Outline	JEDEC No. TO-40
Case.	Metal and Plastic

Terminal Diagram:

Pin 1 - Emitter
Pin 2 - Base



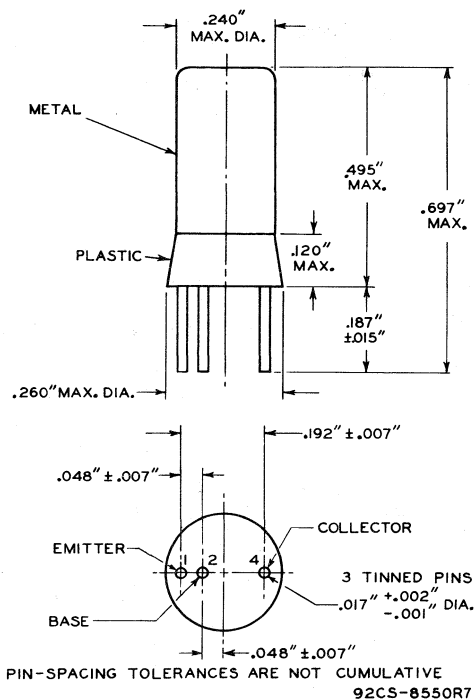
Pin 4 - Collector

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.



2N1527



Transistor

GERMANIUM N-P-N ALLOY-JUNCTION TYPE

For Switching Applications in Commercial
and Military Data-Processing Systems.
N-P-N Counterpart of P-N-P Type 2N404.

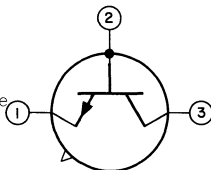
GENERAL DATA

Mechanical:

Dimensions. See Outline T0-5 in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base, Case



Lead 3 - Collector

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} 25 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With dc base-to-emitter
reverse bias volts = -1 V_{CEV} 24 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EBO} 12 max. volts

COLLECTOR CURRENT I_C 100 max. ma

EMITTER CURRENT I_E -100 max. ma

TRANSISTOR DISSIPATION:^a

At free-air temperature of
25° C or below. P 150 max. mw

TEMPERATURE RANGE:

Storage T_{stg} -65 to +100 °C

Operating (Junction). T_J +100 max. °C

LEAD TEMPERATURE:

For 10 seconds maximum^b T_L 235 max. °C

^a See accompanying Rating Chart.

^b Measured 1/16" ± 1/32" down from seating plane.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at
free-air temperature of 25° C unless otherwise specified

Min. Max.

DC Collector Breakdown Voltage

for dc collector ma. = 0.02,

dc emitter ma. = 0. BV_{CBO} 25 - volts



RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

DATA 1
4-62

2N1605

		Min.	Max.	
DC Emitter Breakdown Voltage for dc emitter ma. = 0.02, dc collector ma. = 0. . . .	BV_{EBO}	12	-	volts
DC Collector-to-Emitter Saturation Voltage:	$V_{CE(sat)}$			
With dc collector ma. = 12, dc base ma. = 0.4.		-	0.15	volt
With dc collector ma. = 24, dc base ma. = 1.		-	0.2	volt
DC Base-to-Emitter Voltage:	V_{BE}			
With dc collector ma. = 12, dc base ma. = 0.4.		-	0.35	volt
With dc collector ma. = 24, dc base ma. = 1.		-	0.4	volt
DC Emitter Floating Potential for dc collector volts = 24, and with 11-megohm (min.) voltmeter connected between emitter and base. .	V_{EBF}	-	1	volt
DC Collector-Cutoff Current for dc collector volts = 12, dc emitter ma. = 0, free-air temperature =	I_{CBO}			
25° C		-	5	μa
80° C		-	125	μa
DC Emitter-Cutoff Current for dc emitter volts = 2.5, dc collector ma. = 0 .	I_{EBO}	-	2.5	μa
Collector-to-Base Capacitance for dc collector volts = 6, dc collector ma. = 0. . . .	C_{ob}	-	20	
DC Current Transfer Ratio:	h_{FE}			
With dc collector-to- emitter volts = 0.15, dc collector ma. = 12 . .		30	-	
With dc collector-to- emitter volts = 0.2, dc collector ma. = 24 . .		24	-	
With dc collector-to- emitter volts = 0.25, dc collector ma. = 20 . .		40	-	
Small-Signal Short-Circuit Forward Current Transfer- Ratio Cutoff Frequency for dc collector volts = 6, dc emitter ma. = 1	f_{hfb}	4	-	pf
Total Stored Charge for dc collector supply volts = 5.25, dc collector ma. = 10, dc base ma. = 1	Q_S	-	1400	pc



PERFORMANCE TESTS

This transistor type is tested in strict accordance with Military Specification MIL-S-19500B.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

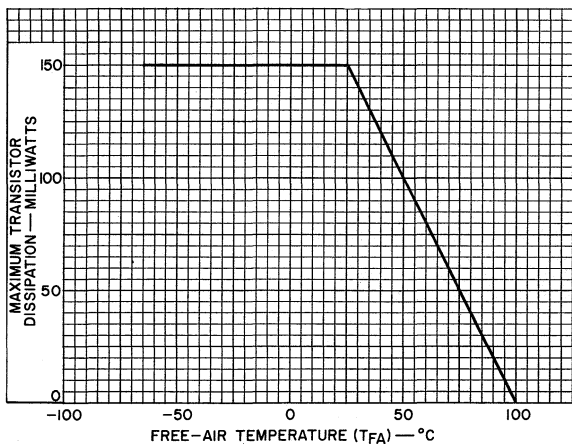
This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board, and to prevent the base from shorting to ground.

It is to be noted that the case of this transistor operates at the base voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



2N1605

RATING CHART



92CS-11460



Transistor

GERMANIUM N-P-N ALLOY-JUNCTION TYPE
For Switching Applications in Commercial
and Military Data-Processing Systems.

N-P-N Counterpart of P-N-P Type 2N404A.

The 2N1605A is the same as the 2N1605 except for the following items:

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} 40 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With dc base-to-emitter

reverse bias volts = -1 V_{CEV} 40 max. volts

TRANSISTOR DISSIPATION:^a

At free-air temperature of

25° C or below. P 200 max. mw

ELECTRICAL CHARACTERISTICS

Min. Max.

DC Collector Breakdown Voltage

for dc collector ma. = 0.01,

dc emitter ma. = 0. BV_{CBO} 40 - volts

DC Emitter Floating Potential

for dc collector volts = 40,

and with 11-megohm (min.)

voltmeter connected between

emitter and base. V_{EBF} - 1 volt

DC Collector-Cutoff Current:

With dc collector volts = 40,

dc emitter ma. = 0.

- 10 μ a

With dc collector volts = 12,

dc emitter ma. = 0, free-air

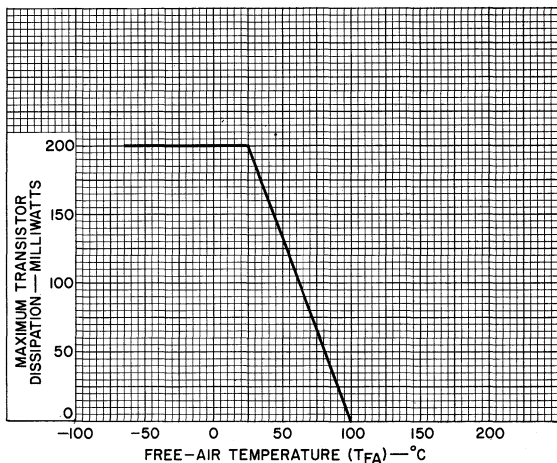
temperature = 80° C - 125 μ a

^a See accompanying Rating Chart.



2N1605A

RATING CHART



92CS-11461



Transistor

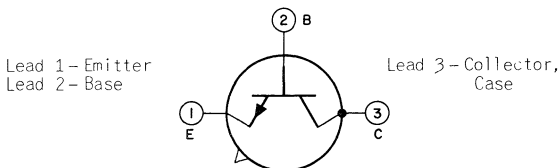
SILICON N-P-N TRIPLE-DIFFUSED PLANAR TYPE

For Small-Signal and Medium Power Applications in Industrial and Military Equipment

Mechanical:

Dimensions. See Outline TO-5 in General Section

Terminal Diagram: BOTTOM VIEW



INDUSTRIAL SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage:

With emitter open V_{CBO} 75 max. volts

Collector-to-Emitter Voltage:

With external base-to-emitter
resistance (ohms) ≤ 10 V_{CER} 50 max. volts

Emitter-to-Base Voltage:

With collector open V_{EBO} 7 max. voltsCollector Current I_C 1 max. amp

Transistor Dissipation:

At case temperatures:^aFrom -65° to 25° C. 3 max. wattsAbove 25° C. Derate linearly $0.0172 \text{ watt}/^{\circ}\text{C}$

At free-air temperatures:

From -65° to 25° C. 0.8 max. wattAbove 25° C. Derate linearly $0.0046 \text{ watt}/^{\circ}\text{C}$

Temperature:

Operating Range (Junction). T_{opr} -65 to 200 $^{\circ}\text{C}$ Storage Range T_{stg} -65 to 300 $^{\circ}\text{C}$ Leads:^bFor 10 seconds maximum. T_L 255 max. $^{\circ}\text{C}$

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, case temperature^a = 25° C

Min. Max.

DC Collector-to-Base Breakdown

Voltage for dc collector ma. =

0.1, emitter current = 0 BV_{CBO} 75 - volts

DC Emitter-to-Base Breakdown

Voltage for dc emitter ma. =

0.25, collector current = 0. BV_{EBO} 7 - volts

← Indicates a change.



2N1613

Min. Max.

DC Collector-to-Emitter Sustaining Voltage for external base-to-emitter resistance (ohms) = 10, pulsed-dc collector ma. = 100c. $V_{CE(sus)}$ 50 - volts

DC Base-to-Emitter Saturation Voltage for pulsed-dc collector ma. = 150c, pulsed-dc base ma. = 15c $V_{BE(sat)}$ - 1.3 volts

DC Collector-to-Emitter Saturation Voltage for pulsed-dc collector ma. = 150c, pulsed-dc base ma. = 15c. $V_{CE(sat)}$ - 1.5 volts

DC Collector-Cutoff Current for dc collector-to-base volts = 60, emitter current = 0, case temperature (°C) =
 25 I_{CBO} - 0.01 μ a
 150. I_{CBO} - 10 μ a

DC Emitter-Cutoff Current for dc emitter-to-base volts = 5, collector current = 0. I_{EBO} - 0.01 μ a

Input Impedance at frequency (kc) = 1:
 With dc collector-to-base volts = 5, dc collector ma. = 1 h_{ib} 24 34 ohms
 With dc collector-to-base volts = 10, dc collector ma. = 5 h_{ib} 4 8 ohms

Input Capacitance for dc emitter-to-base volts = 0.5, collector current = 0 C_{ib} - 80 pf

Output Capacitance for dc collector-to-base volts = 10, emitter current = 0 C_{ob} - 25 pf

Output Conductance at frequency (kc) = 1:
 With dc collector-to-base volts = 5, dc collector ma. = 1 h_{ob} 0.1 0.5 μ mho
 With dc collector-to-base volts = 10, dc collector ma. = 5 h_{ob} 0.1 1 μ mho



	Min.	Max.	
DC Forward-Current Transfer			
Ratio for dc collector-to-emitter volts = 10, dc collector ma. =			
0.1	h_{FE} 20	-	
10 (Pulsed) ^c	h_{FE} 35	-	
150 (Pulsed) ^c	h_{FE} 40	120	
500 (Pulsed) ^c	h_{FE} 20	-	
10 (Pulsed) ^c , case temperature (°C) = -55 . . .	h_{FE} 20	-	
Small-Signal Short-Circuit Forward-Current Transfer Ratio:			
With dc collector-to-emitter volts = 5, dc collector ma. = 1, frequency (kc) = 1			
	h_{fe} 30	100	
With dc collector-to-emitter volts = 10, dc collector ma. = 5, frequency (kc) = 1			
	h_{fe} 35	150	
With dc collector-to-emitter volts = 10, dc collector ma. = 50, frequency (Mc) = 20			
	h_{fe} 3	-	
Small-Signal Open-Circuit Reverse Voltage Transfer (Feedback) Ratio at frequency (kc) = 1:			
With dc collector-to-base volts = 5, dc collector ma. = 1			
	h_{rb} -	0.0003	
With dc collector-to-base volts = 10, dc collector ma. = 5			
	h_{rb} -	0.0003	
Noise Figure for circuit			
bandwidth (cps) = 1, reference signal frequency (kc) = 1, generator resistance (ohms) = 510, dc collector-to-emitter volts = 10, dc collector ma. = 0.3			
	NF -	12	db
Total Switching Time^d (Delay time + rise time + fall time)			
	t_{tsw} -	30	nsec
Thermal Resistance:			
Junction-to-case	θ_{JC} -	58.3	°C/watt
Junction-to-free-air	θ_{JFA} -	219	°C/watt
^a Measured at center of seating plane.			
^b Measured 1/16" ± 1/32" along lead down from seating plane.			
^c Pulse duration of 300 μsec, duty factor of 0.018.			
^d See accompanying <i>Total-Switching-Time Measurement Circuit</i> .			



2N1613

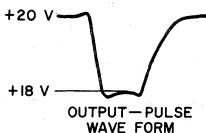
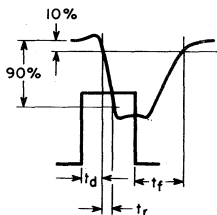
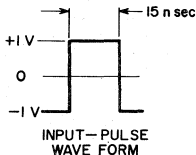
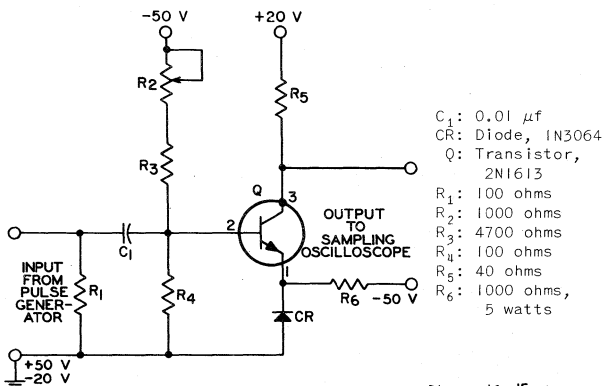
OPERATING CONSIDERATIONS

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

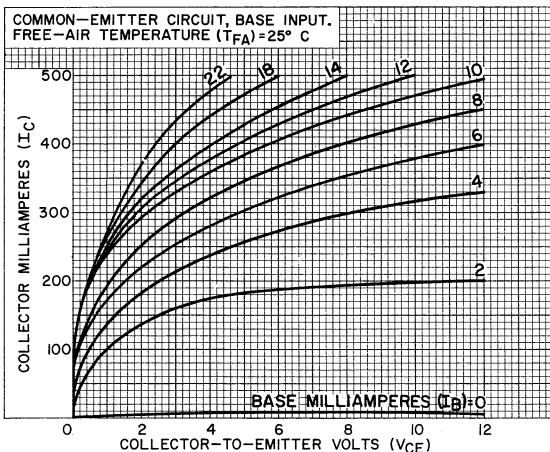
TOTAL-SWITCHING-TIME MEASUREMENT CIRCUIT AND ASSOCIATED WAVE FORMS



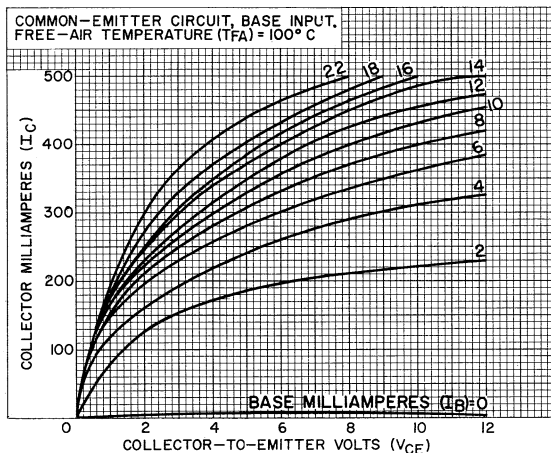
92CS-11186R3



TYPICAL COLLECTOR CHARACTERISTICS



92CS-11189

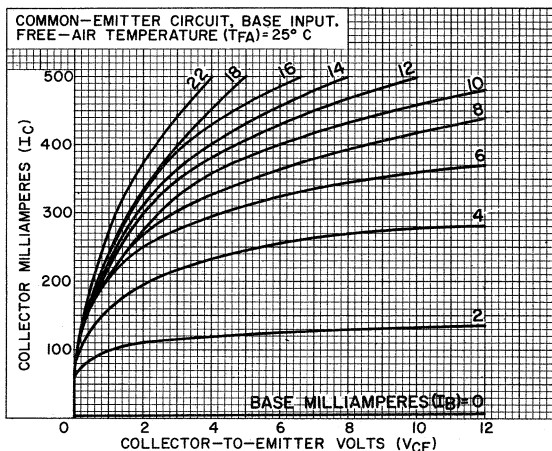


92CS-11180

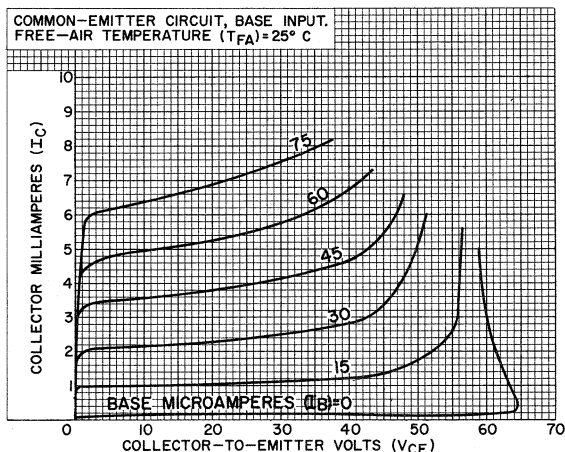


2N1613

TYPICAL COLLECTOR CHARACTERISTICS



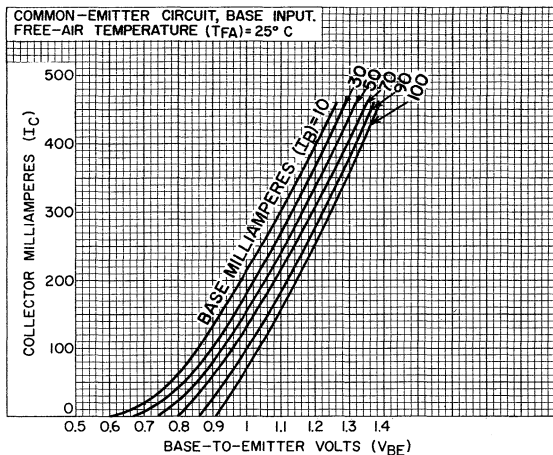
92CS-11191



92CS-11178

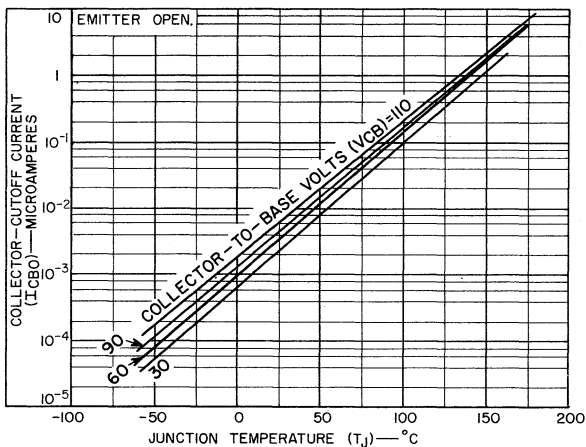


TYPICAL TRANSFER CHARACTERISTICS



92CS-III85

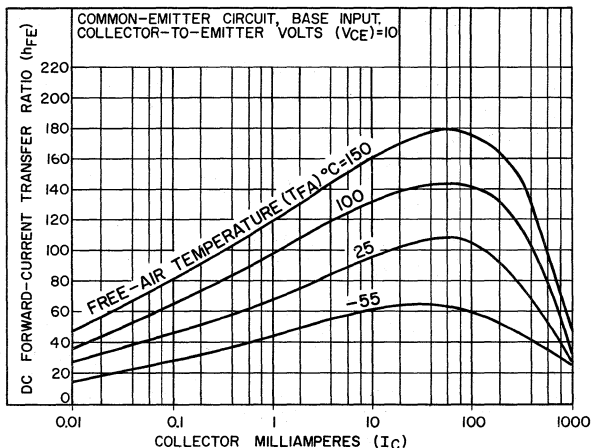
TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



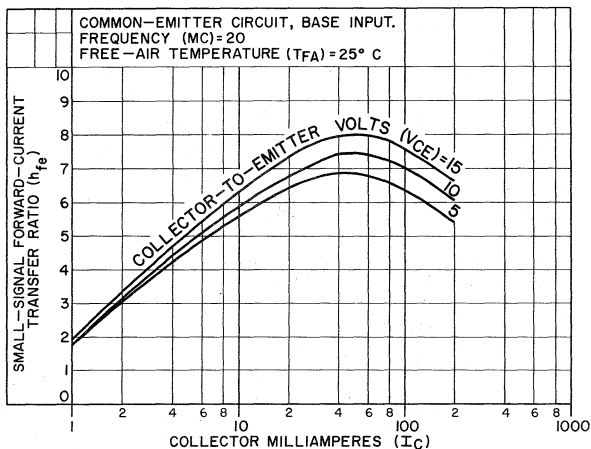
92CS-III70R1



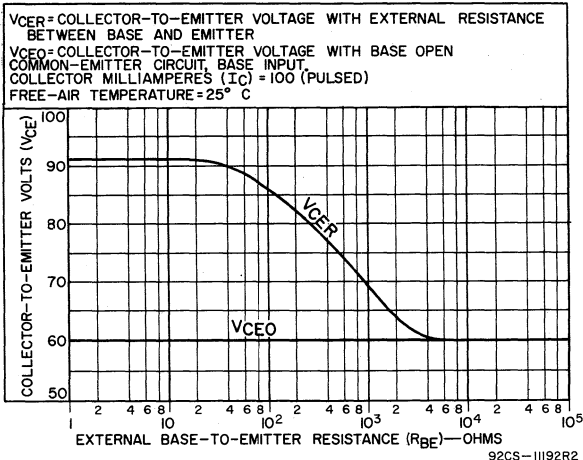
TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



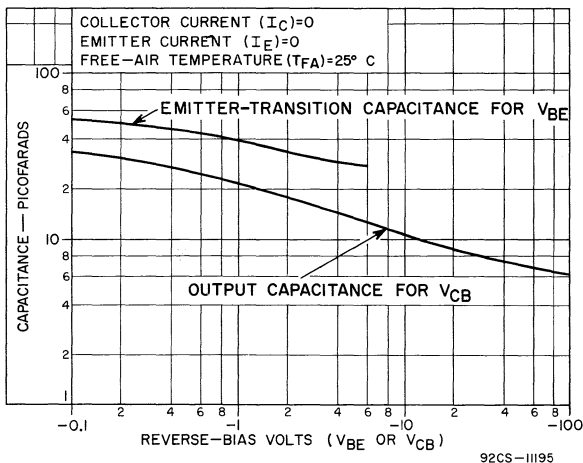
TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



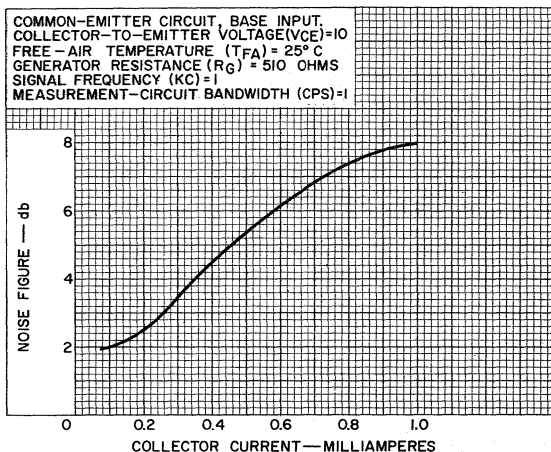
TYPICAL COLLECTOR-TO-EMITTER VOLTAGE CHARACTERISTICS



TYPICAL CAPACITANCE CHARACTERISTICS



TYPICAL NOISE CHARACTERISTIC



92CS-12220



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Radio-Frequency-Amplifier Applications
in Battery-Operated AM Radio Receivers

GENERAL DATA

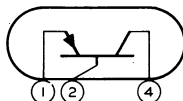
Electrical:

Minimum DC Collector-to-Base Breakdown Voltage (BV_{CBO}) for dc collector $\mu a = -50$, emitter open, ambient temperature = $25^{\circ} C$	-34	volts
Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = -12, emitter open, ambient temperature = $25^{\circ} C$	-16	μa
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = -0.5, collector open, ambient temperature = $25^{\circ} C$	-16	μa
Maximum Junction-Temperature Rise (In free air)	0.4	$^{\circ}C/mw$

Mechanical:

Operating Position	Any
Maximum Overall Length	0.697"
Maximum Seated Length	0.495"
Maximum Diameter	0.260"
Dimensional Outline	JEDEC No. TO-40
Case	Metal and Plastic
Seals	Hermetic
Terminal Diagram:	

Pin 1 - Emitter
Pin 2 - Base



Pin 4 - Collector

RADIO-FREQUENCY AMPLIFIER

Maximum and Minimum Ratings, Absolute-Maximum Values:

DC COLLECTOR-TO-BASE VOLTAGE	-34 max.	volts
DC EMITTER-TO-BASE VOLTAGE	-0.5 max.	volt
DC COLLECTOR CURRENT	-10 max.	ma
DC EMITTER CURRENT	10 max.	ma
TRANSISTOR DISSIPATION:		
At ambient temperature of $25^{\circ} C$	80 max.	mw
At ambient temperature of $55^{\circ} C$	50 max.	mw
At ambient temperature of $71^{\circ} C$	35 max.	mw



AMBIENT TEMPERATURE (During operation) . . . 71 max. °C
 STORAGE-TEMPERATURE RANGE -65 to +85 °C

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage -12 volts
 DC Collector Current 1 ma
 Small-Signal Current Transfer
 Ratio at 1 kc 80

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage -12 volts
 DC Emitter Current 1 ma
 Small-Signal Current Transfer
 Ratio at 1 kc 0.987
 Alpha-Cutoff Frequency 45 Mc

Typical Operation, At Ambient Temperature of 25° C:

In a Common-Emitter Circuit, Base Input at a signal frequency of 1.5 Mc

DC Supply Voltage	-6	-9	-12	volts
DC Collector-to-Emitter Voltage	-5.7	-8.5	-11	volts
DC Emitter Current	1	1	1	ma
Input Resistance, ac output circuit shorted	520	750	1000	ohms
Output Resistance, ac input circuit shorted	0.065	0.11	0.18	megohm
Extrinsic Transconductance	36000	36000	36000	μmhos
Collector-to-Base Capacitance (C _{ob})	2.2 [▲]	2.1 [▲]	2 [▲]	μμf
Maximum Power Gain [●]	40.4	44.3	47.7	db
Useful Power Gain:				
In unneutralized circuit.	25.3	25.5	25.6	db

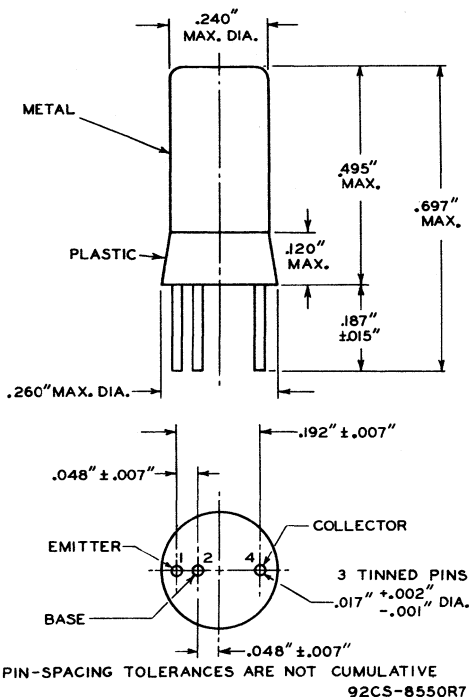
[▲] Maximum variation from this value is 0.9 μμf.

[●] Measured in a single-tuned unilateralized circuit matched to the generator and load impedance for maximum transfer of power (transformer-insertion losses not included).

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

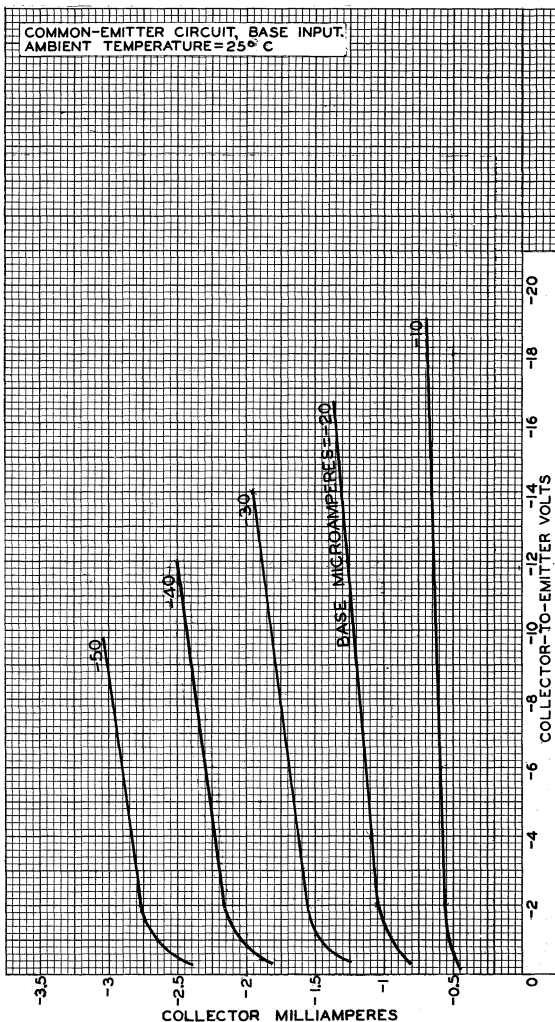




2N1631

TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
AMBIENT TEMPERATURE = 25°C

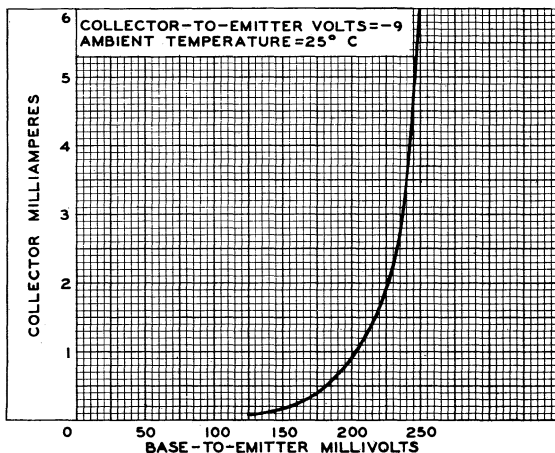
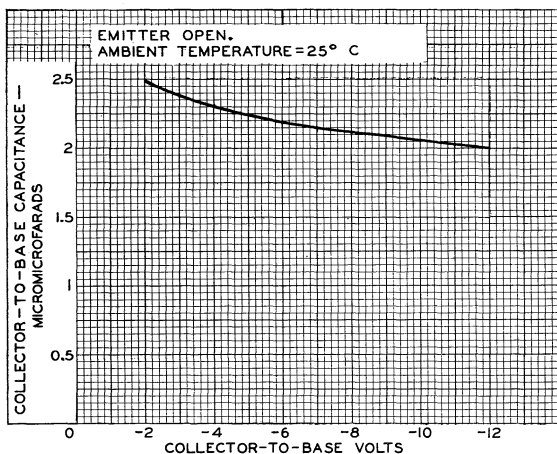


92CM-9107

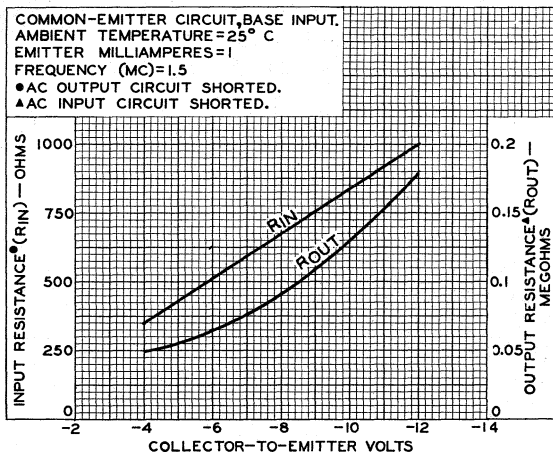
RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.



TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS



92CS-10561RI



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Radio-Frequency-Amplifier Applications in Battery-Operated Radio Receivers

The 2N1632 is the same as the 2N1631 except for the following items:

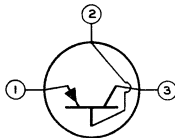
Mechanical:

Maximum Length (Excluding flexible leads)	0.410"
Maximum Diameter	0.260"
Dimensional Outline	JEDEC No. TO-1
Case	Metal
Leads, Flexible	3
Minimum length	1.5"
Orientation and diameter	See Dimensional Outline

Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector
(Adjacent
to red dot
on side of
case)

OPERATING CONSIDERATIONS

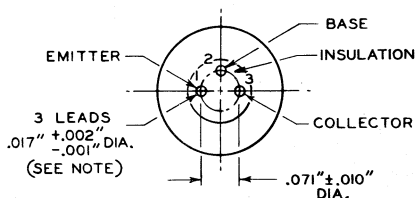
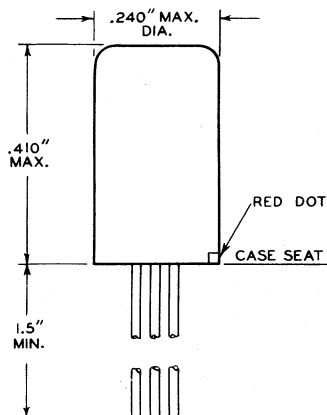
It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using this transistor, the temperature of the solder should not exceed 255° C for a maximum immersion period of 10 seconds.



2N1632



92CS-9148R6

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.05" AND 0.25" FROM THE CASE SEAT. BETWEEN 0.25" AND 1.5", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Radio-Frequency-Amplifier Applications in AM Automobile-Radio Receivers

GENERAL DATA

Electrical:

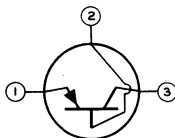
Minimum DC Collector-to-Base Break-down Voltage (BV_{CBO}) for dc collector $\mu a = -50$, emitter open, ambient temperature of 25° C.	-34	volts
Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = -12, emitter open, ambient temperature of 25° C.	-5	μa
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = -1.5, collector open, ambient temperature of 25° C.	-15	μa
Maximum Junction-Temperature Rise (In free air).	0.4	°C/mw

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.410"
Maximum Diameter.	0.240"
Dimensional Outline	JEDEC No. TO-1
Case.	Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector
(Adjacent to red dot on side of case)

RADIO-FREQUENCY AMPLIFIER

Maximum and Minimum Ratings, Absolute-Maximum Values:

DC COLLECTOR-TO-BASE VOLTAGE.	-34 max.	volts
DC EMITTER-TO-BASE VOLTAGE.	-1.5 max.	volts
DC COLLECTOR CURRENT.	-10 max.	ma
DC EMITTER CURRENT.	10 max.	ma



TRANSISTOR DISSIPATION:

At ambient temperature of 25° C.	80 max.	mw
At ambient temperature of 55° C.	50 max.	mw
At ambient temperature of 71° C.	35 max.	mw
AMBIENT TEMPERATURE (During operation) . .	71 max.	°C
STORAGE-TEMPERATURE RANGE.	-65 to +85	°C

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage.	-12	volts
DC Collector Current	-1	ma
Collector-to-Base Capacitance (C_{ob}).	2 [▲]	μ f
Small-Signal Current Transfer Ratio at 1 kc.	80	

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-12	volts
DC Collector Current	-1	ma
Small-Signal Current Transfer Ratio at 1 kc.	0.987	
Alpha-Cutoff Frequency	45	Mc

Typical Operation, At Ambient Temperature of 25° C:

In a common-emitter circuit, base input at a signal frequency of 1.5 Mc

DC Collector-to-Emitter Voltage.	-5.5	-11.2	volts
DC Emitter Current	1	1	ma
Input Resistance, ac output circuit shorted.	520	1000	ohms
Output Resistance, ac input circuit shorted.	0.065	0.18	megohm
Maximum Power Gain	40.4	47.7	db
Maximum Useful Power Gain: In unneutralized circuit	25.3	25.6	db

[▲] Maximum variation from this value is 0.9 μ f.

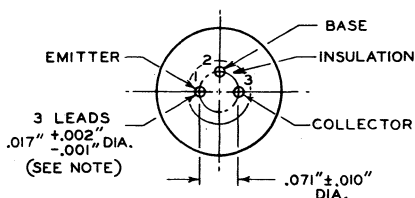
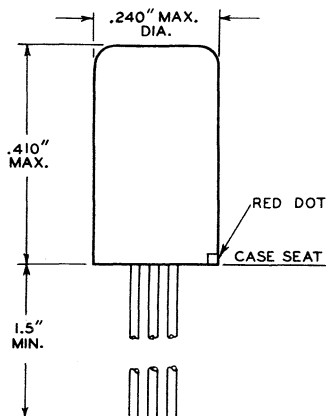
OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation will crack the seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using this transistor, the temperature of the solder should not exceed 255° C for a maximum immersion period of 10 seconds.



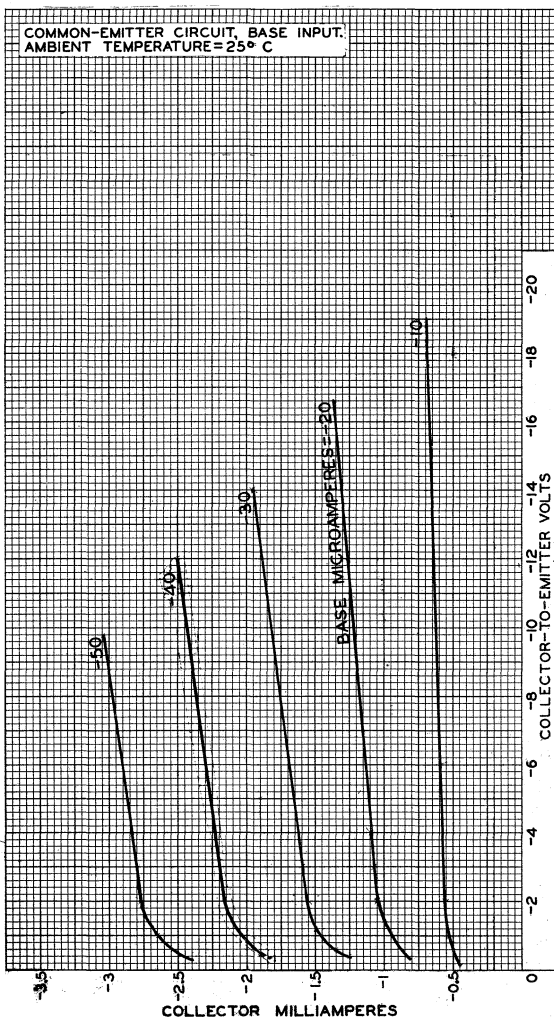


92CS-9148R6

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.05" AND 0.25" FROM THE CASE SEAT. BETWEEN 0.25" AND 1.5", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



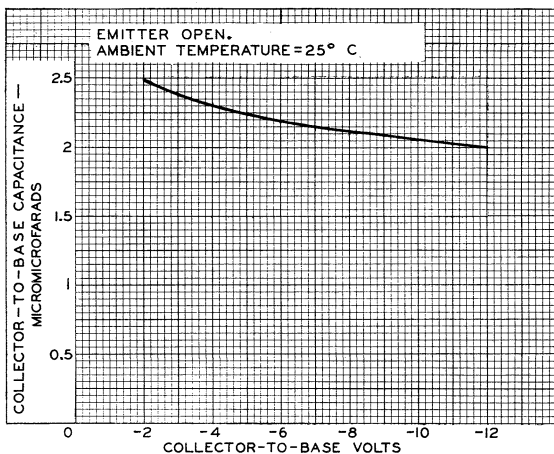
AVERAGE COLLECTOR CHARACTERISTICS



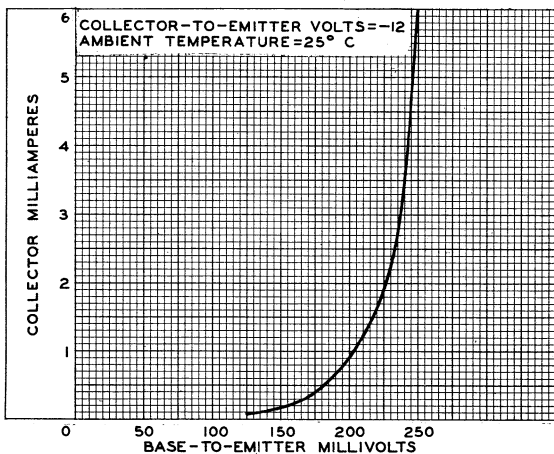
92CM-9107



TYPICAL CHARACTERISTICS



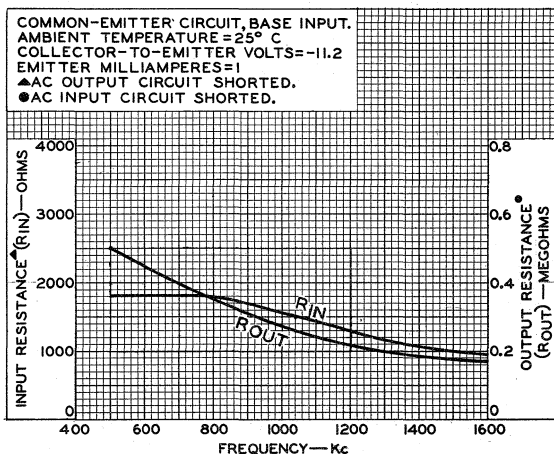
92CS-9820RI



92CS-10556RI



TYPICAL CHARACTERISTICS



92CS-10587RI



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE

For Intermediate-Frequency-Amplifier Applications in AM Automobile-Radio Receivers

GENERAL DATA

Electrical:

Minimum DC Collector-to-Base Breakdown Voltage (BV_{CBO}) for dc collector $\mu a = -50$, emitter open, ambient temperature = $25^{\circ}C$	-34	volts
Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = -12, emitter open, ambient temperature = $25^{\circ}C$	-7	μa
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = -0.5, collector open, ambient temperature = $25^{\circ}C$	-8	μa
Maximum Junction-Temperature Rise (In free air)	0.4	$^{\circ}C/mw$

Mechanical:

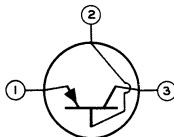
Operating Position	Any
Maximum Length (Excluding flexible leads)	0.410"
Maximum Diameter	0.240"
Dimensional Outline	JEDEC No. TO-1
Case	Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length	1.5"
Orientation and diameter	See <i>Dimensional Outline</i>

Terminal Diagram:

BOTTOM VIEW

Lead 1—Emitter

Lead 2—Base



Lead 3—Collector
(Adjacent to red dot on side of case)

INTERMEDIATE-FREQUENCY AMPLIFIER

Maximum and Minimum Ratings, Absolute-Maximum Values:

DC COLLECTOR-TO-BASE VOLTAGE	-34 max.	volts
DC EMITTER-TO-BASE VOLTAGE	-0.5 max.	volt
DC COLLECTOR CURRENT	-10 max.	ma
DC EMITTER CURRENT	10 max.	ma



TRANSISTOR DISSIPATION:

At ambient temperature of 25° C.	80 max.	mw
At ambient temperature of 55° C.	50 max.	mw
At ambient temperature of 71° C.	35 max.	mw
AMBIENT TEMPERATURE (During operation) . .	71 max.	°C
STORAGE-TEMPERATURE RANGE.	- 65 to +85	°C

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage.	-12	volts
DC Collector Current	-1	ma
Collector-to-Base Capacitance (C_{ob}). . . .	2 [▲]	μ f
Small-Signal Current Transfer Ratio at 1 kc.	75	

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-12	volts
DC Collector Current	-1	ma
Small-Signal Current Transfer Ratio at 1 kc.	0.986	
Alpha-Cutoff Frequency	40	Mc

Typical Operation, At Ambient Temperature of 25° C:

In a common-emitter, base-input, single-stage, 262.5-kc intermediate-frequency-amplifier circuit

DC Collector-to-Emitter Voltage	-5	-11	volts
DC Emitter Current	1.6	2	ma
Input Resistance	1800	1400	ohms
Output Resistance.	0.47	0.72	megohm
Maximum Power Gain	58.6	61.5	db
Useful Power Gain:			
In unneutralized circuit	35	36.6	db

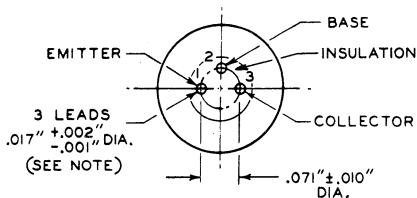
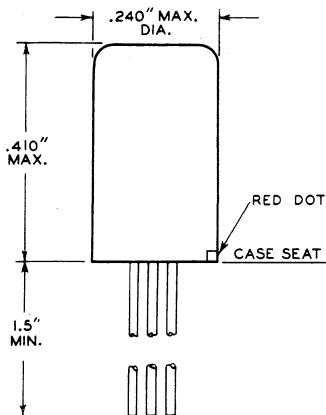
[▲] Maximum variation from this value is 0.9 μ f.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.

When dip soldering is employed in the assembly of printed circuitry using this transistor, the temperature of the solder should not exceed 255° C for a maximum immersion period of 10 seconds.

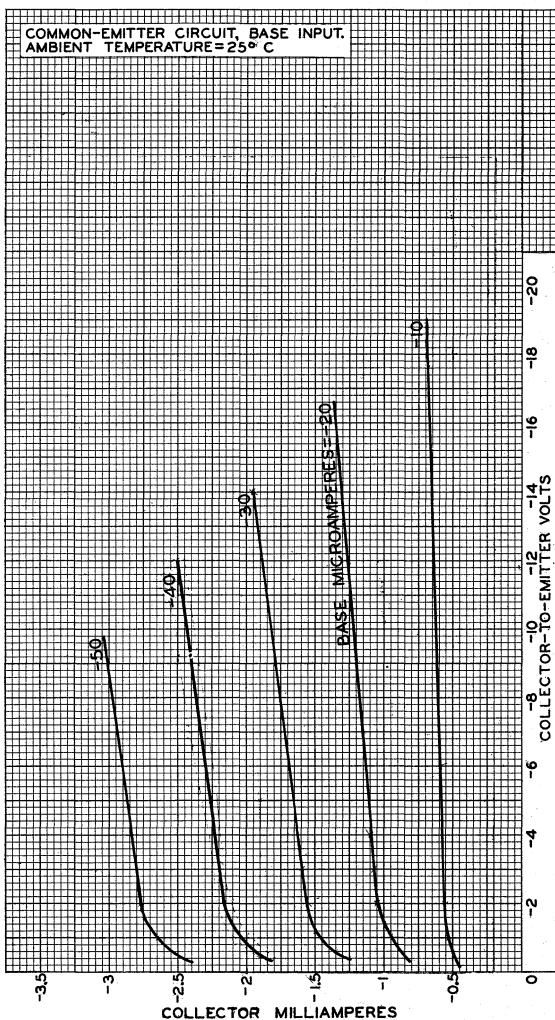


92CS-9148R6

NOTE: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.05" AND 0.25" FROM THE CASE SEAT. BETWEEN 0.25" AND 1.5", A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.



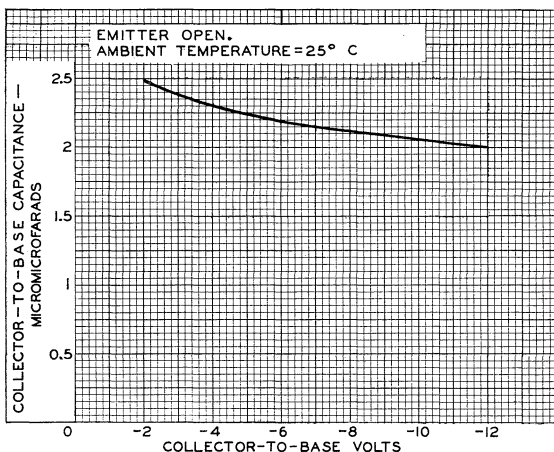
AVERAGE COLLECTOR CHARACTERISTICS



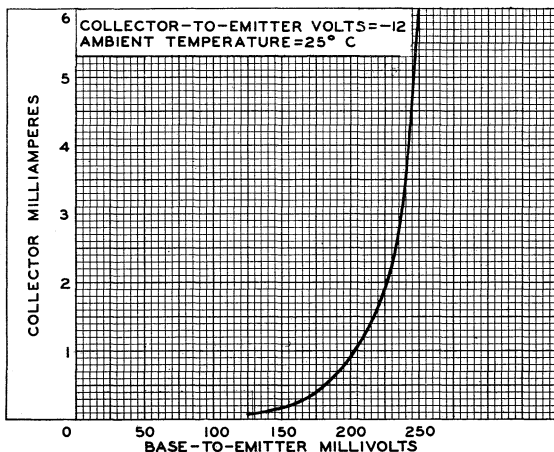
92CM-9107



TYPICAL CHARACTERISTICS



92CS-9820RI



92CS-10556RI



Drift-Field Transistor

GERMANIUM P-N-P ALLOY TYPE
For Converter Applications in
AM Automobile-Radio Receivers

GENERAL DATA

Electrical:

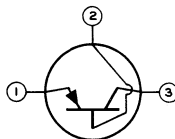
Minimum DC Collector-to-Base Breakdown Voltage (BV_{CBO}) for dc collector $\mu a = -50$, emitter open, ambient temperature = $25^{\circ} C$.	-34	volts
Maximum DC Collector-Cutoff Current (I_{CBO}) for dc collector-to-base volts = -12, emitter open, ambient temperature = $25^{\circ} C$.	-7	μa
Maximum DC Emitter-Cutoff Current (I_{EBO}) for dc emitter-to-base volts = -0.5, collector open, ambient temperature = $25^{\circ} C$.	-8	μa
Maximum Junction-Temperature Rise (In free air)	0.4	$^{\circ}C/mw$

Mechanical:

Operating Position	Any
Maximum Length (Excluding flexible leads)	0.410"
Maximum Diameter	0.240"
Dimensional Outline	JEDEC No. TO-1
Case	Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length	1.5"
Orientation and diameter	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1—Emitter

Lead 2—Base



Lead 3—Collector
(Adjacent to red dot on side of case)

CONVERTER

Maximum and Minimum Ratings, Absolute-Maximum Values:

DC COLLECTOR-TO-BASE VOLTAGE	-34 max.	volts
DC EMITTER-TO-BASE VOLTAGE	-0.5 max.	volt
DC COLLECTOR CURRENT	-10 max.	ma
DC EMITTER CURRENT	10 max.	ma



2N1639

TRANSISTOR DISSIPATION:

At ambient temperature of 25° C.	80 max.	mw
At ambient temperature of 55° C.	50 max.	mw
At ambient temperature of 71° C.	35 max.	mw
AMBIENT TEMPERATURE (During operation)	71 max.	°C
STORAGE-TEMPERATURE RANGE.	-65 to +85	°C

Characteristics, At Ambient Temperature of 25° C:

Common-Emitter Circuit, Base Input

DC Collector-to-Emitter Voltage.	-12	volts
DC Collector Current	-1	ma
Collector-to-Base Capacitance (C _{ob}).	2 [▲]	μmf
Small-Signal Current Transfer Ratio at 1 kc.	75	

Common-Base Circuit, Emitter Input

DC Collector-to-Base Voltage	-12	volts
DC Collector Current	-1	ma
Small-Signal Current Transfer Ratio at 1 kc.	0.986	
Alpha-Cutoff Frequency	45	Mc

Typical Operation, At Ambient Temperature of 25° C:

In a common-emitter, base input, 1.5-Mc converter circuit

DC Collector-to-Emitter Voltage.	-5	-11	volts
DC Emitter Current	0.65	0.65	ma
Input Resistance	1850	2200	ohms
Output Resistance at 262.5 kc.	0.1	0.2	megohm
RMS Base-to-Emitter Oscillator-Injection Voltage	100	100	mv
Useful Conversion Power Gain	35.4	37	db

▲ Maximum variation from this value is 0.9 μmf.

OPERATING CONSIDERATIONS, DIMENSIONAL OUTLINE, and CURVES

shown under Type 2N1638 also apply to the 2N1639



Mesa Transistor

GERMANIUM P-N-P DIFFUSED-JUNCTION TYPE

For High-Speed Switching Service in Commercial and Military Data-Processing Systems

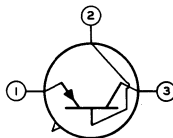
GENERAL DATA

Mechanical:

Operating Position.	Any
Maximum Length (Excluding flexible leads)	0.260"
Maximum Diameter.	0.370"
Dimensional Outline	JEDEC No. TO-5
Case.	Welded, Metal
Seals	Hermetic
Leads, Flexible	3
Minimum length.	1.5"
Orientation and diameter.	See <i>Dimensional Outline</i>
Terminal Diagram:	BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base



Lead 3 - Collector

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	-13 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE.	-12 max.	volts
EMITTER-TO-BASE VOLTAGE ^a	-4 max.	volts
COLLECTOR CURRENT	-100 max.	ma
EMITTER CURRENT	100 max.	ma
TRANSISTOR DISSIPATION: ^b		
At ambient temperature of 25° C	150 max.	mw
At ambient temperature of 55° C	75 max.	mw
At ambient temperature of 71° C	35 max.	mw

AMBIENT-TEMPERATURE RANGE:

Operating and storage	-65 to +85	°C
---------------------------------	------------	----

LEAD TEMPERATURE:

For immersion in molten solder		
for 10 seconds maximum.	255 max.	°C

Typical Operation:

<i>In an inverter circuit at ambient temperature of 25° C</i>		
Collector-to-Emitter Voltage.	-5	volts
Base Resistor	3000	ohms
Collector Resistor.	120	ohms
"Turn-On" Base Voltage.	-5	volts
"Turn-Off" Base Voltage	5	volts
"On" Collector Current.	-40	ma

← Indicates a change.



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DATA 1
4-61

"Turn-On" Base Current.	-1.6	ma
"Turn-Off" Base Current	1.6	ma
Switching Time:		
Delay time (t_d)	0.07	μ sec
Rise time (t_r)	0.06	μ sec
Storage time (t_s)	0.08	μ sec
Fall time (t_f)	0.05	μ sec

^a This rating may be exceeded and the emitter-to-base junction operated in the breakdown condition provided the emitter dissipation is limited to 30 milliwatts at 25° C. For ambient temperatures above 25° C, the dissipation should be reduced by 0.5 milliwatt/°C.

^b See accompanying *Rating Chart* and also *Transistor-Dissipation Rating Chart* in General Section.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base unless otherwise specified. Ambient temperature of 25° C.

Min. Typical Max.

DC Collector Breakdown				
Voltage for dc collector ma. = -0.02, emitter open . BV_{CBO}	-13	-30	-	volts
DC Collector-to-Emitter Breakdown				
Voltage. BV_{CERL}	-12	-25	-	volts
DC Emitter Breakdown				
Voltage for dc emitter ma. = -0.1, collector open . . . BV_{EBO}	-4	-6	-	volts
DC Punch-Through				
Voltage. V_P	-12	-30	-	volts
DC Base-to-Emitter				
Voltage for dc collector ma. = -40, dc base ma. = -1 . . V_{BE}	-	-0.4	-0.6	volt
DC Collector-Cutoff				
Current for collector volts = -6, emitter open I_{CBO}	-	-1	-3	μ a
→ Collector Capacitance for dc collector volts = -6, emitter open C_C	-	8	12	μ mf
DC Current Transfer Ratio:				
h_{FE}				
With dc collector-to-emitter volts = -0.3, dc collector ma. = -10. . .	50	75	-	
With dc collector-to-emitter volts = -0.5, dc collector ma. = -40. . .	50	85	-	

→ Indicates a change.

Gain-Bandwidth Product^c

for dc collector-to-emitter volts = -3, dc collector ma. = -10

GBW 50 80 - Mc

Thermal Resistance:

Junction-to-free air. R_T - - 400 °C/watt

Total Stored Charge:

Q_S

With dc collector ma.

= -10, dc base ma. = -0.4. . - 110 160 $\mu\text{coulombs}$

With dc collector ma.

= -40, dc base ma. =

-1.6. - 200 410 $\mu\text{coulombs}$

Thermal Time Constant τ_1 - 10 - msec

^c Frequency at which the current transfer ratio is equal to 1.

OPERATING CONSIDERATIONS

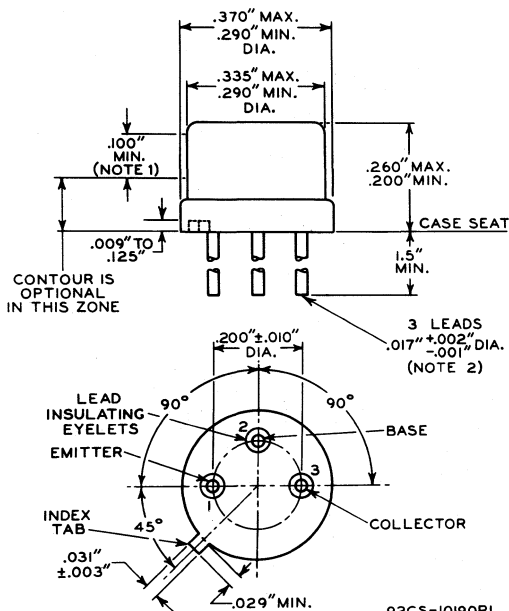
It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the glass seals of the leads and damage the transistor.



2N1683

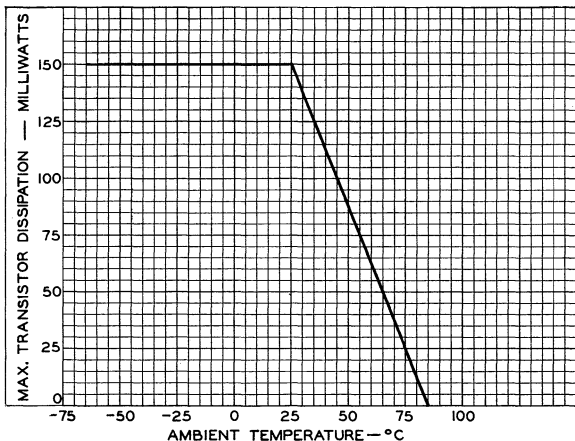
JEDEC No. T0-5



NOTE 1: THE DIAMETER IN THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE TOTAL VARIATION IN ACTUAL DIAMETER FROM THE TRUE DIAMETER, DUE TO TAPER AND OUT OF ROUND WITHIN THIS ZONE, WILL NOT EXCEED $0.010''$.

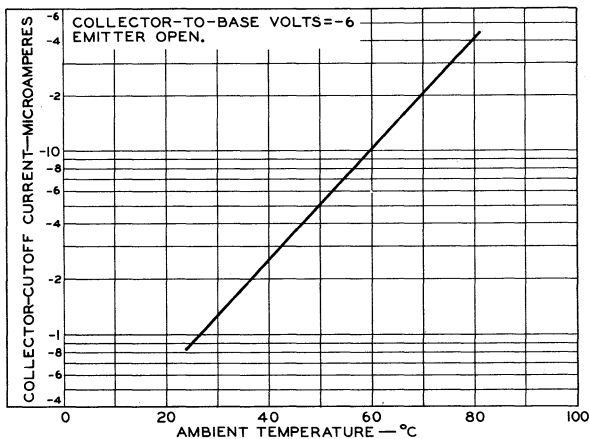
NOTE 2: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN $0.05''$ AND $0.25''$ FROM THE CASE SEAT. BETWEEN $0.25''$ AND $1.5''$, A MAXIMUM DIAMETER OF $0.021''$ IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

RATING CHART



92CS-10232RI

TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTIC



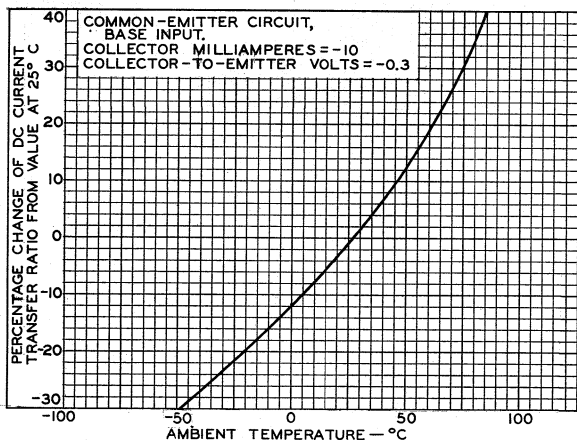
92CS-10213RI



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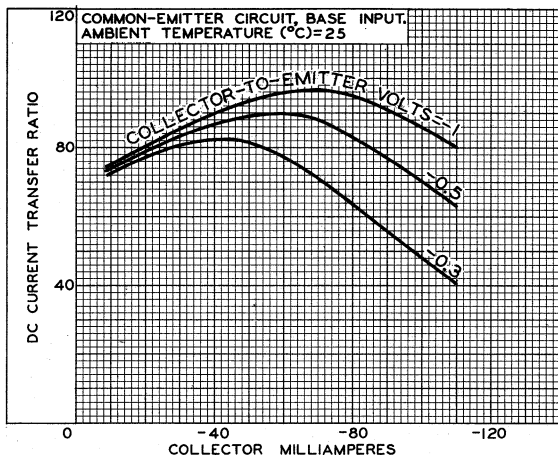
DATA 3
4-61

TYPICAL CHARACTERISTIC



92CS-10199R3

TYPICAL DC CURRENT- TRANSFER-RATIO CHARACTERISTICS

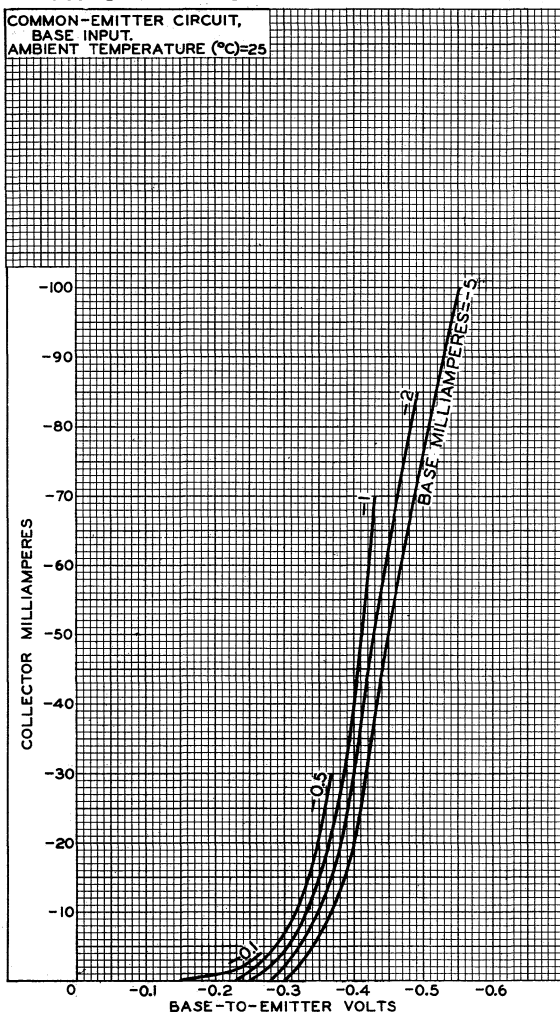


92CS-10830



TYPICAL TRANSFER CHARACTERISTICS

COMMON-EMITTER CIRCUIT,
BASE INPUT.
AMBIENT TEMPERATURE ($^{\circ}\text{C}$)=25



92CM-10229

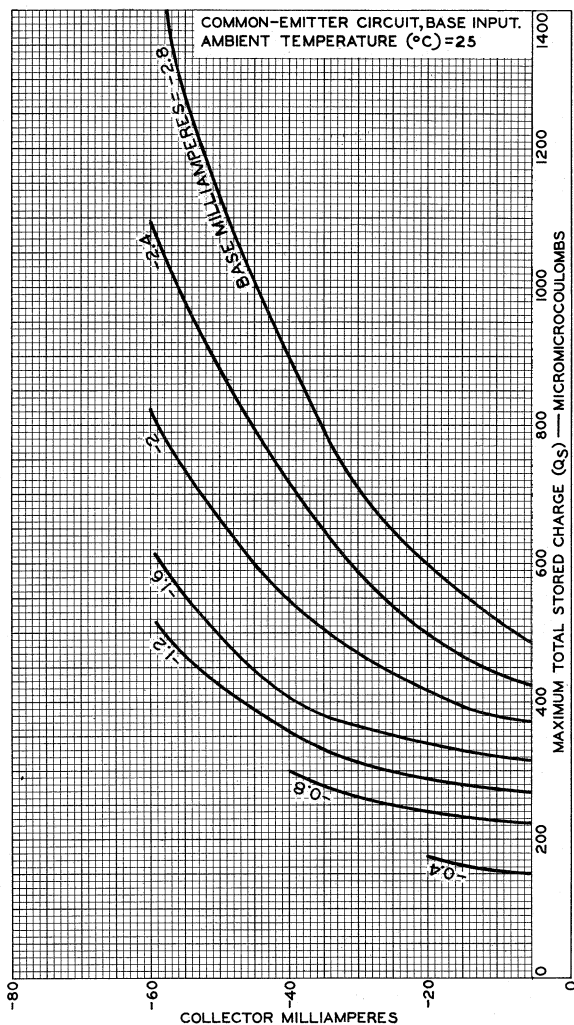


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DATA 4
4-61

2N1683

MAXIMUM TOTAL- STORED-CHARGE CHARACTERISTICS



92CM-10815



Power Transistor

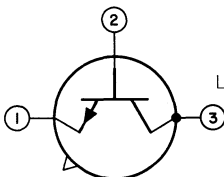
SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Industrial Applications

GENERAL DATA

Mechanical:

Dimensions. See Outline TO-5 in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, and relay-actuating circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} 60 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With dc base-to-emitter reverse bias volts = -1.5. V_{CEV} 60 max. volts

With base open (Sustaining voltage)^a $V_{CEO(sus)}$ 40 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EBO} 6 max. volts

COLLECTOR CURRENT I_C 1 max. amp

BASE CURRENT I_B 0.75 max. amp

TRANSISTOR DISSIPATION:^b

At case temperature^c of 25° C or below. P_T 5 max. watts

TEMPERATURE RANGE:

Storage T_{STG} -65 to +200 °C

Junction (Operating). T_J -65 to +200 °C

LEAD TEMPERATURE:^d

For 10 seconds maximum. T_L 255 max. °C

Characteristics:

At case temperature^c of 25° C

Small-Signal, Short Circuit

Forward Current Transfer Ratio

for dc collector-to-emitter

volts = 4, dc collector ma.

= 5 h_{fe} 40



2N1700

Small-Signal, Short Circuit

Forward Current Transfer-
Ratio Cutoff Frequency for
dc collector-to-base volts

= 28, dc collector ma. = 5 f_{hfb} 1.2 Mc

Collector-to-Base Capacitance
for dc collector-to-base

volts = 40. C_{ob} 150 pf

Thermal Time Constant τ_l 10 msec

Typical Operation:

*In accompanying typical common-emitter, base input,
power switching circuit at case temperature^c of 25° C*

DC Collector Supply Voltage V_{CC} 12 volts

DC Base Supply Voltage. V_{BB} -8.5 volts

On DC-Collector Current I_C 200 ma

Turn-On DC-Base Current I_{B1} 20 ma

Turn-Off DC-Base Current. I_{B2} -8.5 ma

Generator Resistance. R_G 50 ohms

Switching Time:

Delay time. t_d 0.2 μ sec

Rise time t_r 1 μ sec

Storage time. t_s 0.6 μ sec

Fall time t_f 1 μ sec

^a The Collector-to-Emitter Sustaining Voltage [$V_{CE0(sus)}$] with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($\alpha_{eff} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^b See accompanying Rating Chart and also Transistor-Dissipation Rating Chart in General Section.

^c Measured at center of seating plane.

^d Measured 1/16" $\pm$ 1/32" along lead down from seating plane.

ELECTRICAL CHARACTERISTICS

*Voltage values are given with respect to base and
case temperature^c of 25° C unless otherwise specified*

Min. Max.

DC Collector-to-Emitter Voltage:

With dc emitter reverse bias

volts = -1.5, dc collector

ma. = 0.5 V_{CEV} 60 - volts

With base open (Sustaining

voltage), dc collector ma.

= 50, dc base ma. = 0 $V_{CE0(sus)}^a$ 40 - volts

DC Base-to-Emitter Voltage

for dc collector-to-emitter

volts = 4, dc collector

ma. = 100 V_{BE} - 2 volts



DC Collector-Cutoff Current					I_{CBO}	
for dc collector volts = 30,						
dc emitter ma. = 0, case						
temperature ^c =						
25° C					-	75 μ a
150° C.					-	1000 μ a
DC Emitter-Cutoff Current for						
dc emitter volts = 6, dc						
emitter ma. = 0					I_{EBO}	25 μ a
DC Forward-Current Transfer						
Ratio for dc collector-to-						
emitter volts = 4, dc						
collector ma. = 100					h_{FE}	20 80
DC Collector-to-Emitter						
Saturation Resistance for						
dc collector ma. = 100, dc						
base ma. = 10					$r_{CE(sat)}$	10 ohms
Thermal Resistance:						
Junction-to-case.					θ_{JC}	35 °C/watt
Junction-to-free air.					θ_{JFA}	200 °C/watt

^a The Collector-to-Emitter Sustaining Voltage [$V_{CE0(sus)}$] with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($\alpha_{EM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^c Measured at center of seating plane.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

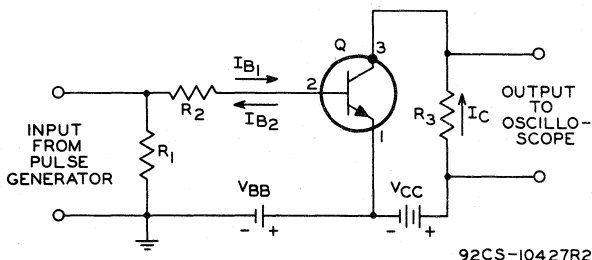
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



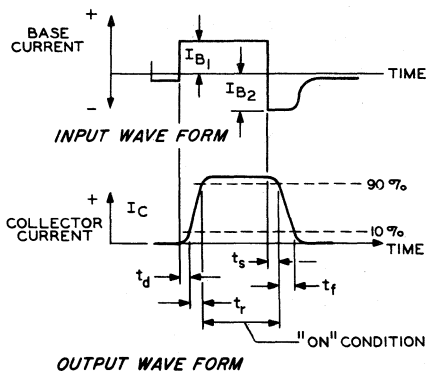
2N1700

TYPICAL POWER-SWITCHING CIRCUIT

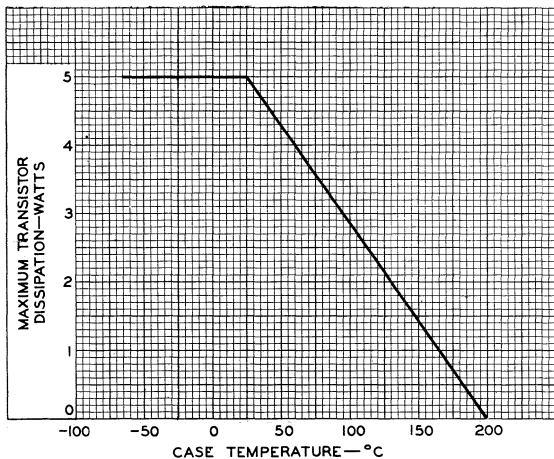


Q: Transistor type 2N1700
 R_1 : 50 ohms, 1 watt
 R_2 : 700 ohms, 1 watt
 R_3 : 59 ohms, 2 watts
 V_{BB} : -8.5 volts
 V_{CC} : 12 volts

ASSOCIATED WAVE FORMS



RATING CHART



92CS-10446R2



TYPICAL COLLECTOR CHARACTERISTICS

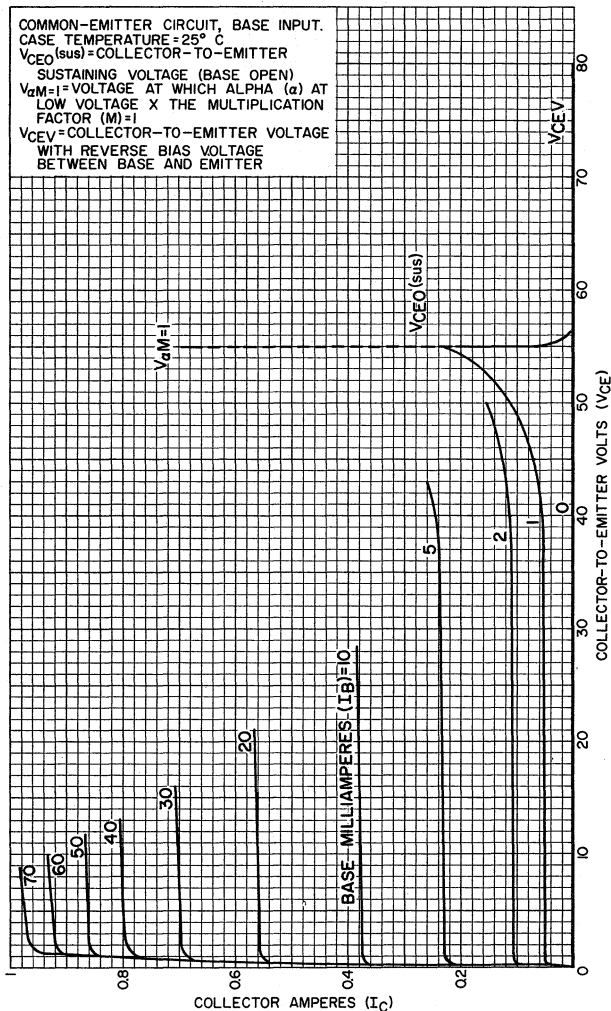
COMMON-EMITTER CIRCUIT, BASE INPUT.
CASE TEMPERATURE = 25° C

$V_{CE0(sus)}$ = COLLECTOR-TO-EMITTER

SUSTAINING VOLTAGE (BASE OPEN)

$V_{\alpha M=1}$ = VOLTAGE AT WHICH ALPHA (α) AT
LOW VOLTAGE X THE MULTIPLICATION
FACTOR (M) = 1

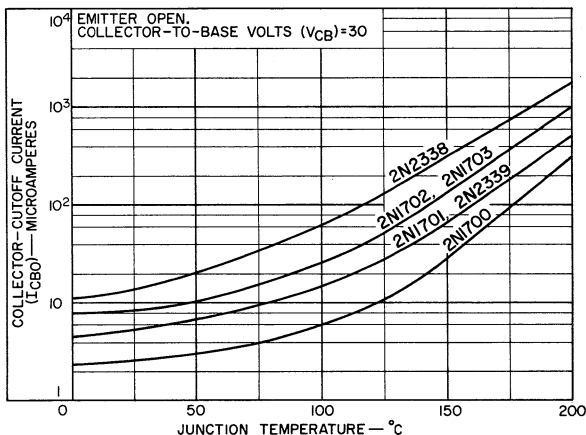
V_{CEV} = COLLECTOR-TO-EMITTER VOLTAGE
WITH REVERSE BIAS VOLTAGE
BETWEEN BASE AND EMITTER



92CM-11555R1

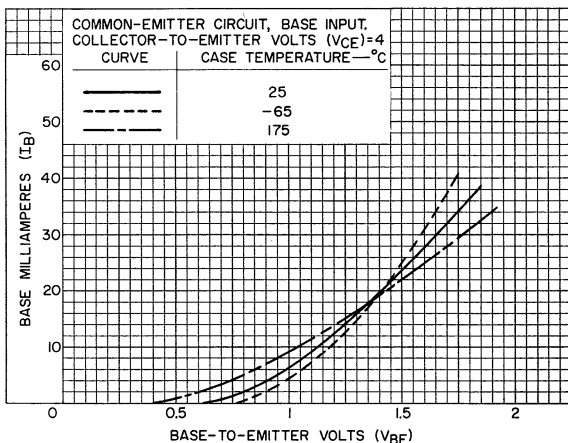


TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



92CS-11585

TYPICAL BASE CHARACTERISTICS

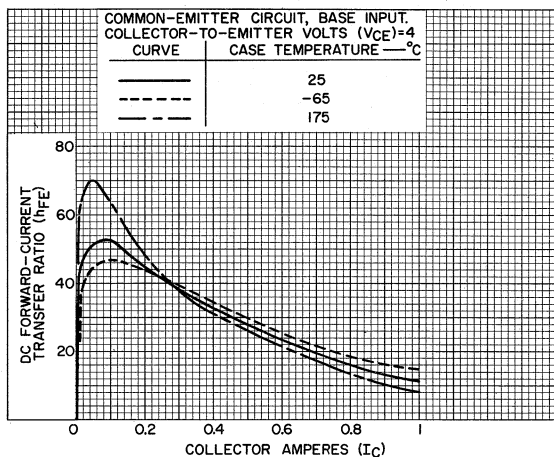


92CS-11569



2N1700

TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



92CS-11573



Power Transistor

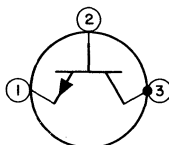
SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Industrial Applications

GENERAL DATA

Mechanical:

Dimensions. See Outline TO-8 in General Section
Terminal Diagram: BOTTOM VIEW

Pin 1-Emitter
Pin 2-Base



Pin 3-Collector,
Case

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, and relay-actuating circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CBO}	60 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With dc base-to-emitter reverse bias volts = -1.5. . .	V_{CEV}	60 max.	volts
With base open (Sustaining voltage) ^a	$V_{CEO(sus)}$	40 max.	volts
EMITTER-TO-BASE VOLTAGE:			
With collector open	V_{EBO}	6 max.	volts
COLLECTOR CURRENT	I_C	2.5 max.	amp
BASE CURRENT	I_B	1 max.	amp
TRANSISTOR DISSIPATION: ^b			
At case temperature ^c of 25° C or below.	P_T	25 max.	watts
TEMPERATURE RANGE:			
Storage	T_{STG}	-65 to +200	°C
Junction (Operating).	T_J	-65 to +200	°C
PIN TEMPERATURE: ^d			
For 10 seconds maximum.	T_P	235 max.	°C

Characteristics:

At case temperature^c of 25° C

Small-Signal, Short-Circuit Forward Current Transfer-Ratio Cutoff Frequency for dc collector-to-base volts = 28, dc collector ma. = 5. . .			
	f_{hfb}	1	Mc



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DATA 1
4-62

2N1701

Collector-to-Base Capacitance

for dc collector-to-base

volts = 40. C_{ob} 175 pf

Thermal Time Constant τ_I 10 msec

Typical Operation:

In accompanying typical common-emitter, base input, power switching circuit at case temperature^c of 25° C

DC Collector Supply Voltage . . . V_{CC} 12 volts

DC Base Supply Voltage. V_{BB} -8.5 volts

On DC-Collector Current I_C 750 ma

Turn-On DC-Base Current I_{B1} 65 ma

Turn-Off DC-Base Current. I_{B2} -35 ma

Generator Resistance. R_G 50 ohms

Switching Time:

Delay time. t_d 0.2 μ sec

Rise time t_r 1 μ sec

Storage time. t_s 0.8 μ sec

Fall time t_f 1.1 μ sec

^a The Collector-to-Emitter Sustaining Voltage [$V_{CE0(sus)}$] with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{\alpha M} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^b See accompanying Rating Chart and also Transistor-Dissipation Rating Chart in General Section.

^c Measured at center of seating plane.

^d Measured 1/16" $\pm$ 1/32" along pin down from seating plane.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and case temperature^c of 25° C unless otherwise specified.

Min. Max.

DC Collector-to-Emitter

Voltage:

With dc emitter reverse

bias volts = -1.5, dc

collector ma. = 0.75 . . .

V_{CEV} 60 - volts

With base open (Sustaining

voltage), dc collector

ma. = 100, dc base

ma. = 0

$V_{CE0(sus)}^a$ 40 - volts

DC Base-to-Emitter Voltage

for dc collector-to-

emitter volts = 4, dc

collector ma. = 300 . . .

V_{BE} - 3 volts

DC Collector-Cutoff Current

for dc collector volts

= 30, dc emitter ma. =

0, case temperature^c =

25° C

- 100 μ a

150° C

- 1500 μ a

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DC Emitter-Cutoff Current

for dc emitter volts =

-6, dc emitter ma. = 0. . .

 I_{EBO}

-

50

 μa

DC Current Forward-Transfer

Ratio for dc collector-

to-emitter volts = 4, dc

collector ma. = 300 . . .

 h_{FE}

20

80

DC Collector-to-Emitter

Saturation Resistance for

dc collector ma. = 300, dc

base ma. = 30.

 $r_{CE(sat)}$

-

5

ohms

Thermal Resistance:

Junction-to-case.

 θ_{JC}

-

7

 $^{\circ}C/watt$

Junction-to-free air.

 θ_{JFA}

-

100

 $^{\circ}C/watt$

- a The Collector-to-Emitter Sustaining Voltage [$V_{CE(sus)}$] with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($\alpha_{EM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

- c Measured at center of seating plane.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connection can be made to the collector, base, and emitter pins by means of clips or by soldering directly to the pins. Soldering of connections to the pins may be made close to the pin seals provided care is taken to conduct excessive heat away from the pin seal, otherwise the heat of the soldering operation will crack the seals of the pins and damage the transistor.

Under no circumstances should the case be soldered to the heat sink because the heat of the soldering operation will permanently damage the transistor.

It is important that this transistor be securely fastened to a heat sink. Amounting clamp is provided for this purpose.

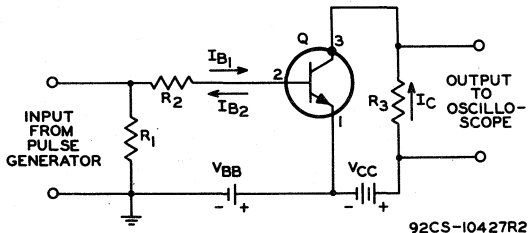
In applications where the chassis is connected to the negative terminal of the voltage supply, it will be necessary to use an anodized-aluminum insulator having high thermal conductivity, or a 0.002" mica insulator between the transistor case and the chassis. The insulator should extend beyond the mounting clamp. An aluminum washer should be drilled or punched to provide the two mounting holes, and the clearance holes for the collector, emitter, and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolt and the chassis, it is important that an insulating washer be used between the bolt and the chassis. See *Suggested Mounting Arrangement*.



2N1701

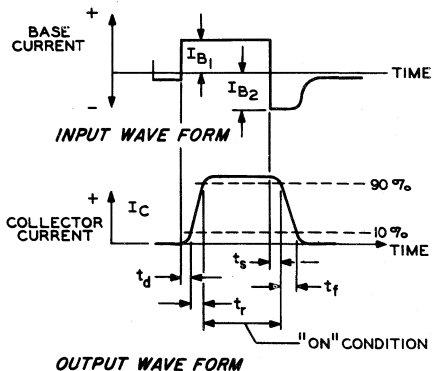
It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

TYPICAL POWER-SWITCHING CIRCUIT

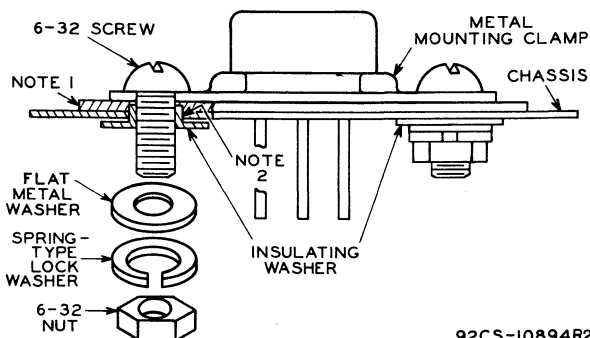


Q: Transistor type 2N1701
 R_1 : 50 ohms, 1 watt
 R_2 : 220 ohms, 1 watt
 R_3 : 15.9 ohms, 2 watts
 V_{BB} : -8.5 volts
 V_{CC} : 12 volts

ASSOCIATED WAVE FORMS



SUGGESTED MOUNTING ARRANGEMENT



NOTE 1: 0.002" MICA INSULATOR OR ANODIZED ALUMINUM INSULATOR (DRILLED, OR PUNCHED WITH BURRS REMOVED).

NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.

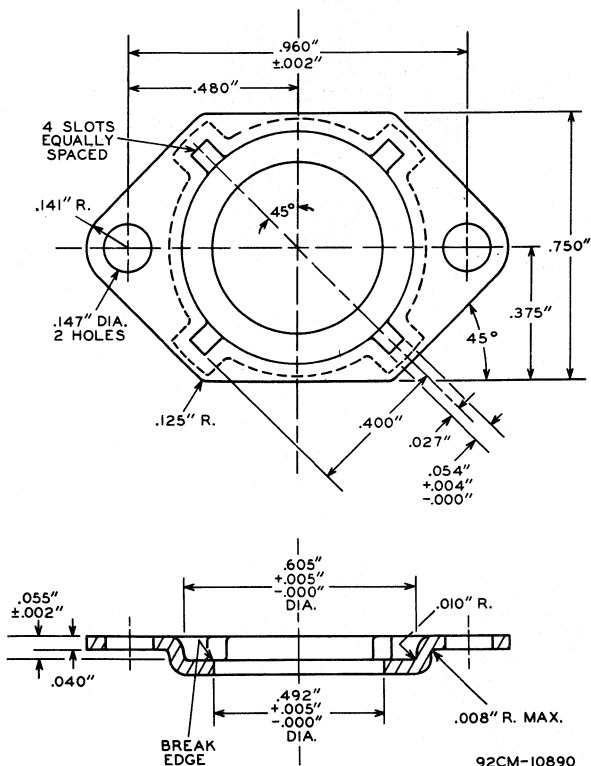
THE METAL MOUNTING CLAMP, MICA OR ALUMINUM INSULATORS, AND INSULATING WASHERS ARE SUPPLIED WITH EACH TRANSISTOR.



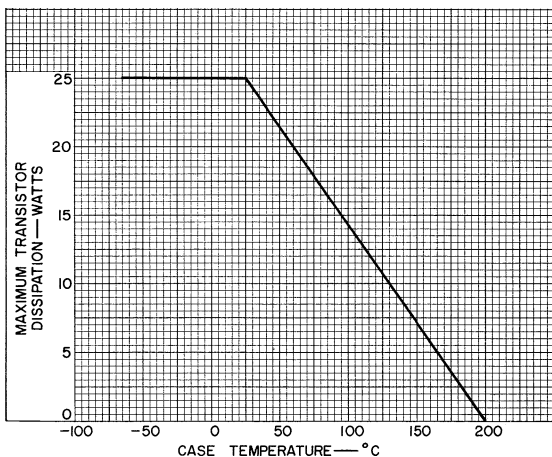
2N1701

MOUNTING CLAMP

Supplied with Each Transistor



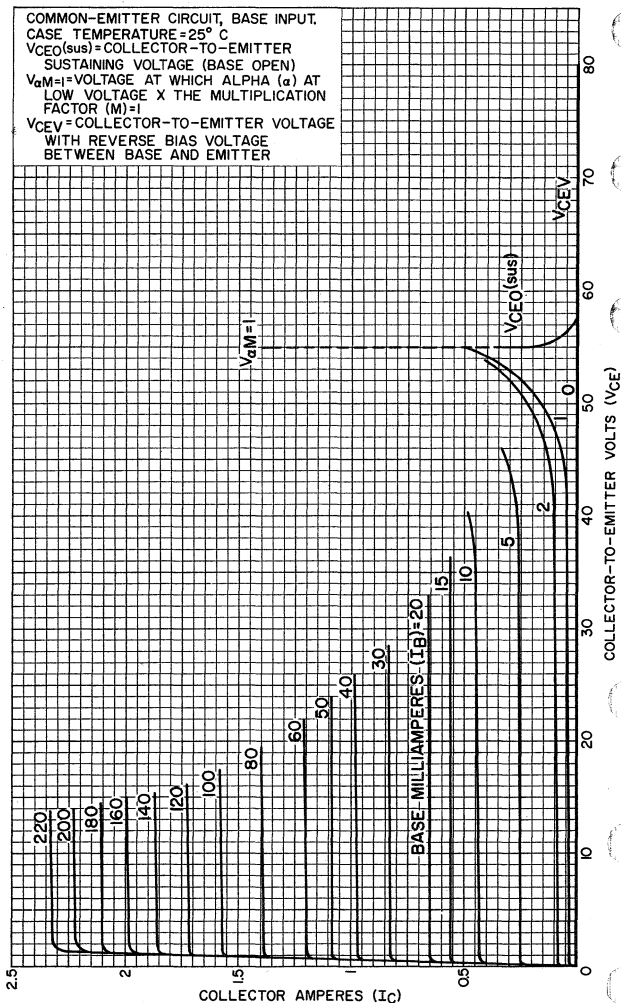
RATING CHART



92CS-10442R2



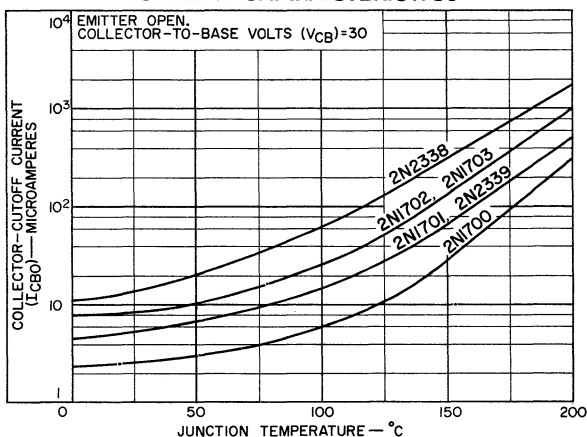
TYPICAL COLLECTOR CHARACTERISTICS



92CM-11562R1

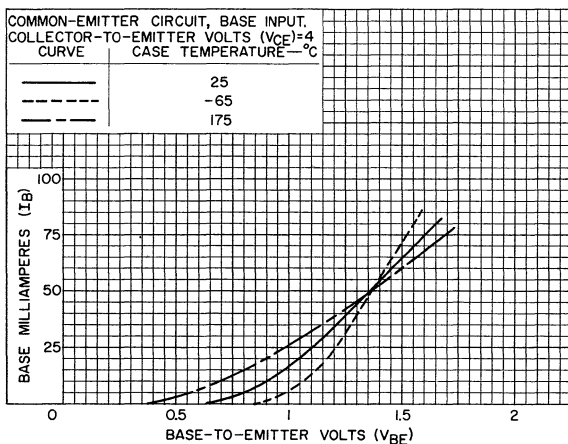


TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



92CS-11585

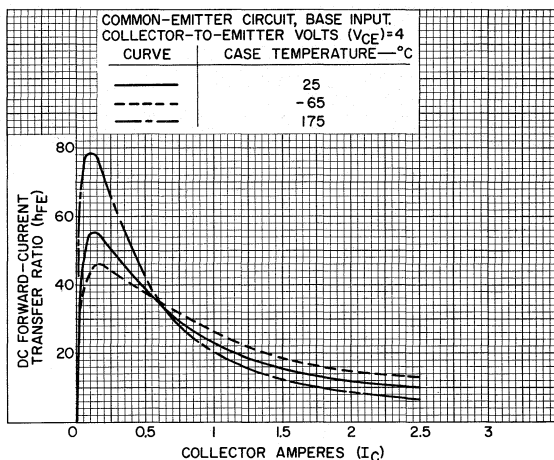
TYPICAL BASE CHARACTERISTICS



92CS-11571



TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



92CS-11574



Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE
For Industrial Applications

GENERAL DATA

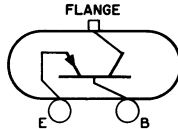
Mechanical:

Dimensions. See accompanying Outline (Similar to JEDEC No. TO-3)

Terminal Diagram (See Dimensional Outline):

E - Emitter

B - Base



MOUNTING FLANGE—
Collector,
Case

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, and relay-actuating circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CBO} 60 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With dc base-to-emitter reverse bias volts = -1.5. V_{CEV} 60 max. volts

With base open (Sustaining voltage)^a. $V_{CEO(sus)}$ 40 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EBO} 6 max. volts

COLLECTOR CURRENT. I_C 5 max. amp

BASE CURRENT. I_B 2.5 max. amp

TRANSISTOR DISSIPATION:^b P_T

At mounting-flange temperature^c of 25° C or below 75 max. watts

TEMPERATURE RANGE:

Storage. T_{STG} -65 to +200 °C

Junction (Operating) T_J -65 to +200 °C

Characteristics:

At mounting-flange temperature^c of 25° C

Small-Signal, Short Circuit

Forward Current Transfer-

Ratio Cutoff Frequency for

dc collector-to-base volts

= 28, dc collector ma. = 5 f_{hfb} 1 Mc

Collector-to-Base Capacitance

for dc collector-to-base

volts = 40 C_{ob} 200 pf

Thermal-Time Constant. τ_l 12 msec



Typical Operation:

In accompanying typical common-emitter, base input, power switching circuit at mounting-flange temperature^c of 25° C

DC Collector Supply Voltage.	V _{CC}	12	volts
DC Base Supply Voltage.	V _{BB}	-8.5	volts
On DC-Collector Current.	I _C	1.5	amp
Turn-On DC-Base Current.	I _{B1}	0.3	amp
Turn-Off DC-Base Current.	I _{B2}	-0.15	amp
Generator Resistance.	R _G	50	ohms
Switching Time:			
Delay time.	t _d	0.2	μsec
Rise time.	t _r	1	μsec
Storage time.	t _s	1	μsec
Fall time.	t _f	1.2	μsec

^a The Collector-to-Emitter Sustaining Voltage [V_{CE0(sus)}] with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity (V_{AM} = 1; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^b See accompanying Rating Chart and also Transistor-Dissipation Rating Chart in General Section.

^c Measured at center of seating plane.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and mounting-flange temperature^c of 25° C unless otherwise specified

Min. Max.

DC Collector-to-Emitter Voltage:				
With dc emitter reverse bias volts = -1.5, dc collector ma. = 1. . . .	V _{CEV}	60	-	volts
With base open (Sustaining voltage), dc collector ma. = 100, dc base ma. = 0.	V _{CE0(sus)} ^a	40	-	volts
DC Base-to-Emitter Voltage for dc collector-to-emitter volts = 4, dc collector ma. = 800	V _{BE}	-	4	volts
DC Collector-Cutoff Current for dc collector volts = 30, dc emitter ma. = 0, mounting-flange temperature ^c =	I _{CBO}			
25° C.		-	200	μa
150° C.		-	2000	μa
DC Emitter-Cutoff Current for dc emitter volts = 6, dc collector ma. = 0	I _{EBO}	-	100	μa



DC Forward-Current Transfer- Ratio for dc collector-to- emitter volts = 4, dc col- lector ma. = 800.	h_{FE}	15	60	
DC Collector-to-Emitter Satu- ration Resistance for dc col- lector ma. = 800, dc base ma. = 80.	$r_{CE(sat)}$	-	4	ohms
Thermal Resistance: Junction-to-mounting-flange .	θ_{JMF}	-	2.33	$^{\circ}\text{C}/\text{watt}$

- a The Collector-to-Emitter Sustaining Voltage [$V_{CE(sus)}$] with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).
- c Measured at center of seating plane.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

This transistor utilizes the Loranger Mfg. Corp. socket No. 2149, or equivalent. Electrical connection can also be made to the base and emitter pins by soldering directly to the pins. Soldering of connections to the pins may be made close to the pin seals provided care is taken to conduct excessive heat away from the pin seal, otherwise the heat of the soldering operation will crack the seals of the pins and damage the transistor.

Under no circumstances should the mounting flange be soldered to the heat sink because the heat of the soldering operation will permanently damage the transistor.

It is important that the mounting flange which serves as the collector terminal be securely fastened to a heat sink.

In applications where the chassis is connected to the negative terminal of the voltage supply, it will be necessary to use an anodized-aluminum insulator having high thermal conductivity, or a 0.002" mica insulator between the mounting flange and the chassis. The insulator should extend beyond the mounting-flange. An aluminum washer should be drilled or punched to provide the two mounting holes, and the clearance holes for the emitter and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolt and the chassis, it is important that an insulating washer be used between the bolt and the chassis. See *Suggested Mounting Arrangement*.

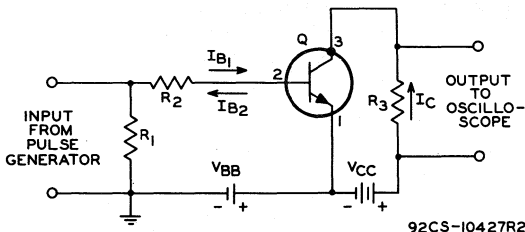
← Indicates a change.



2N1702

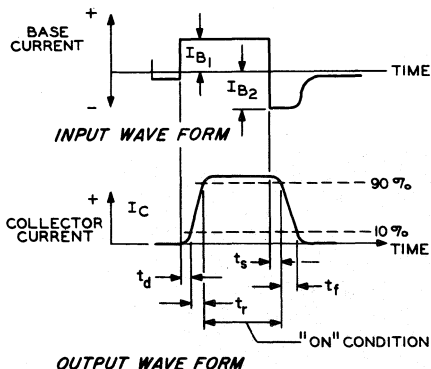
It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard, when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

TYPICAL POWER-SWITCHING CIRCUIT

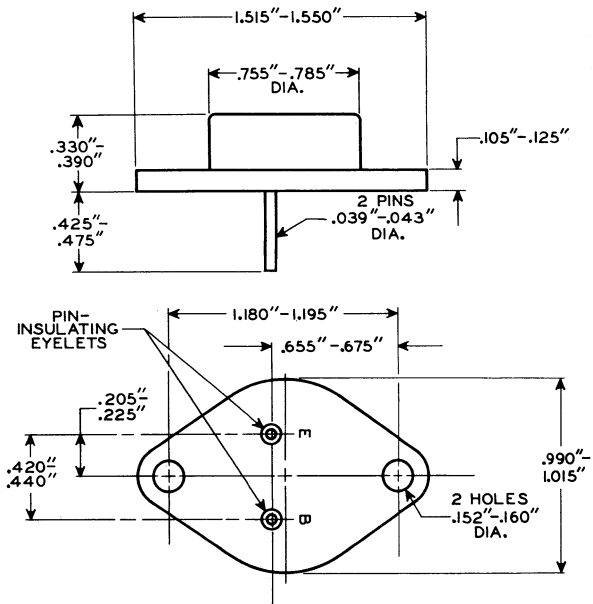


Q: Transistor type 2N1702
 R_1 : 50 ohms, 1 watt
 R_2 : 30 ohms, 1 watt
 R_3 : 7.8 ohms, 2 watts
 V_{BB} : -8.5 volts
 V_{CC} : 12 volts

ASSOCIATED WAVE FORMS



Similar to JEDEC No.T0-3



92CS-10504R2

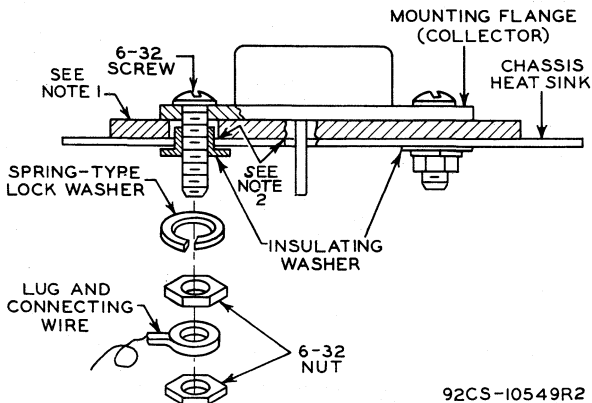


RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

DATA 3
4-62

2N1702

SUGGESTED MOUNTING ARRANGEMENT

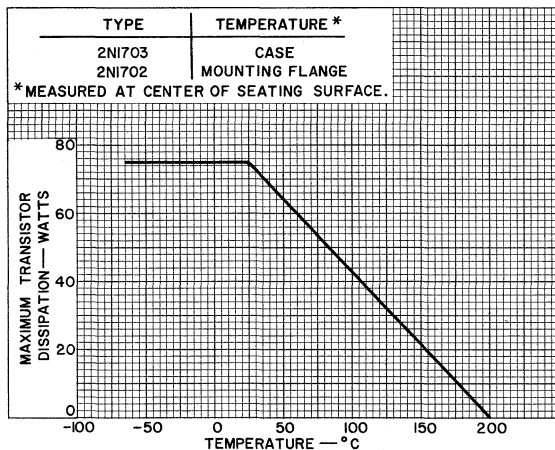


92CS-10549R2

NOTE 1: 0.002" MICA INSULATOR OR ANODIZED ALUMINUM INSULATOR (DRILLED, OR PUNCHED WITH BURRS REMOVED).

NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.

RATING CHART



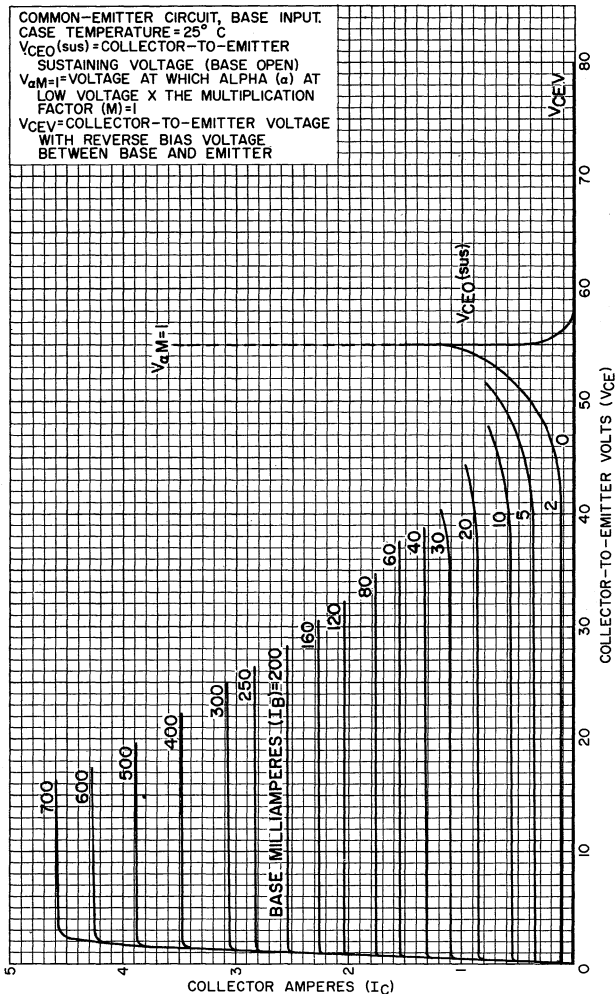
92CS-10903

RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division

Somerville, N. J.



TYPICAL COLLECTOR CHARACTERISTICS



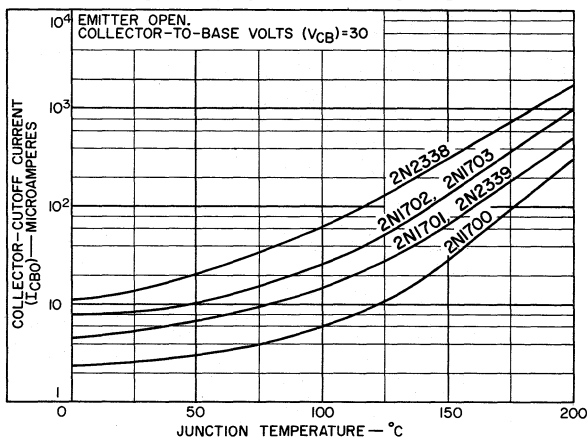
92CM-11564R1



RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

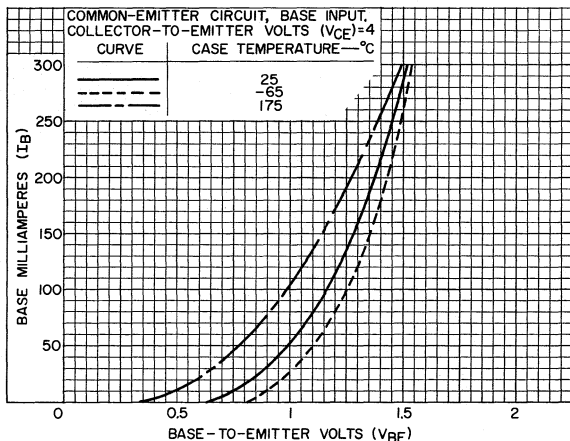
DATA 4
4-62

TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



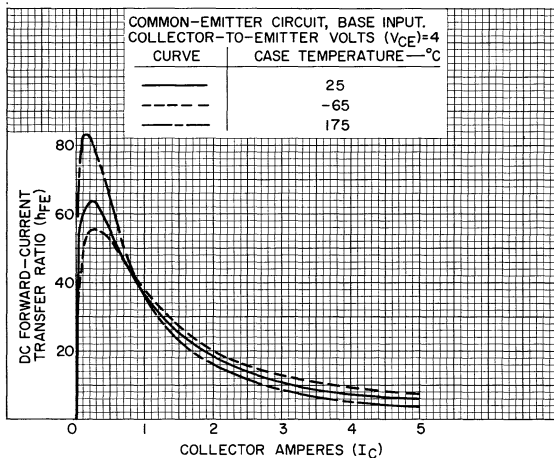
92CS-11585

TYPICAL BASE CHARACTERISTICS



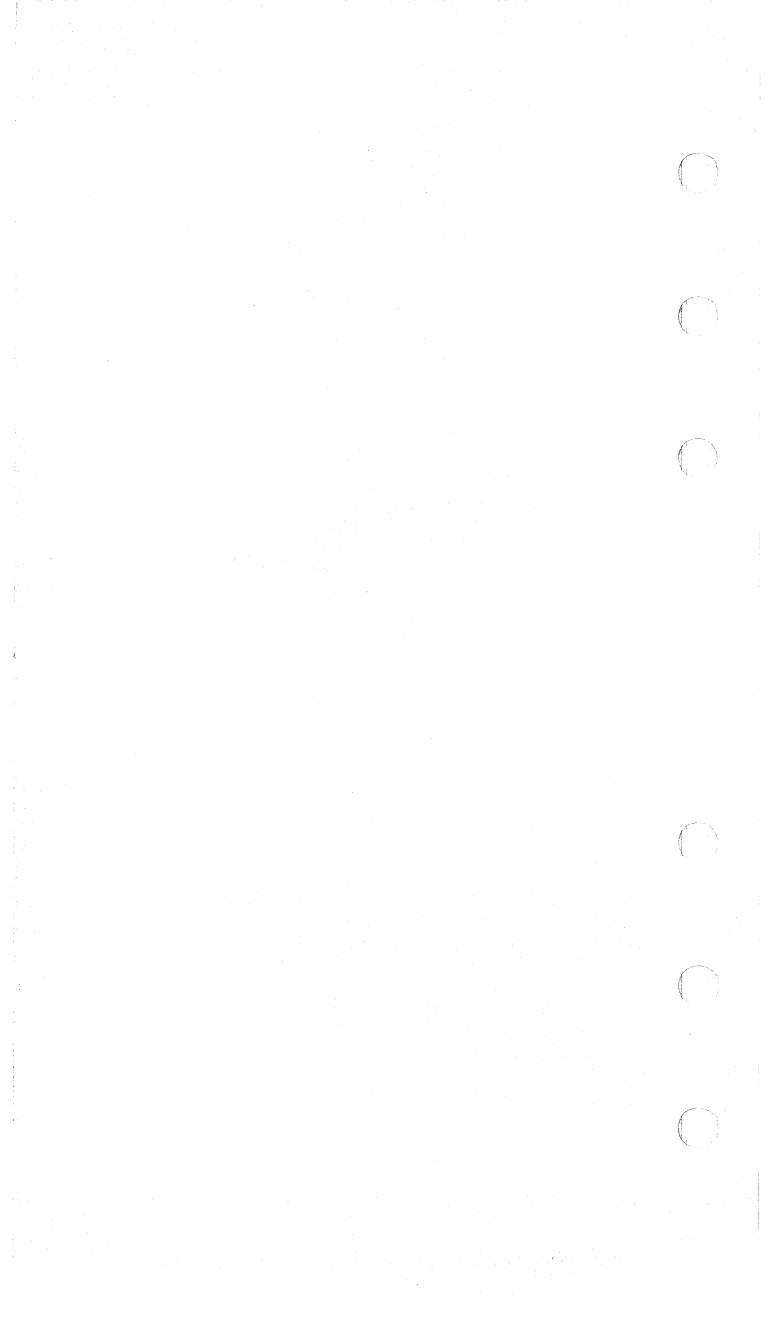
92CS-11567



TYPICAL DC FORWARD-CURRENT
TRANSFER-RATIO CHARACTERISTICS

92CS-11575





Transistor

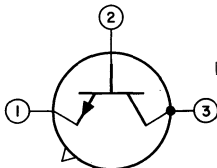
SILICON N-P-N TRIPLE-DIFFUSED-JUNCTION PLANAR TYPE
For Industrial and Military Applications

GENERAL DATA

Mechanical:

Dimensions. See *Outline T0-5* in General Section
 Terminal Diagram: **BOTTOM VIEW**

Lead 1 - Emitter
 Lead 2 - Base



Lead 3 - Collector,
 Case

INDUSTRIAL SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CBO}	75 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With external resistance (ohms) $\leq$ 10 between base and emitter . . .	V_{CER}	50 max.	volts
EMITTER-TO-BASE VOLTAGE:			
With collector open	V_{EBO}	7 max.	volts
TRANSISTOR DISSIPATION: ^a			
At case temperature ^b of 25° C or below.		3 max.	watts
At free-air temperature of 25° C or below.		0.8 max.	watt
TEMPERATURE RANGE:			
Storage	T_{STG}	-65 to +300	°C
Junction (Operating).	T_J	-65 to +200	°C

^a See accompanying *Rating Chart*.

^b Measured at center of seating plane.

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25° C unless otherwise specified

Min. Max.

DC Collector Breakdown			
Voltage for dc collector ma. = 0.1, dc emitter ma. = 0	BV_{CBO}	75	- volts
DC Emitter Breakdown			
Voltage for dc collector ma. = 0, dc emitter ma. = 0.1	BV_{EBO}	7	- volts



RADIO CORPORATION OF AMERICA
 Semiconductor & Materials Division Somerville, N. J.

DATA 1
 4-62

DC Collector-to-Emitter Reach-Through Voltage for dc emitter floating potential (volts) = 1.5, dc collector ma. = 0.1	V_{RT}	75	-	volts
DC Collector-to-Emitter Sustaining Voltage for dc pulse collector ma. = 100, external resistance between base and emitter (ohms) ≤ 10	$V_{CER(sus)}$	50	-	volts
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 150, dc base ma. = 15	$V_{CE(sat)}$	-	1.5	volts
DC Base-to-Emitter Saturation Voltage for dc collector ma. = 150, dc base ma. = 15	$V_{BE(sat)}$	-	1.3	volts
DC Collector-Cutoff Current for dc collector volts = 60, dc emitter ma. = 0, case temperature ^b =	I_{CBO}			
25° C		-	0.01	μ a
150° C		-	10	μ a
DC Emitter-Cutoff Current for dc emitter volts = 5, dc collector ma. = 0	I_{EBO}	-	0.005	μ a
Input Resistance at frequency of 1 kc:	h_{ib}			
With dc collector volts = 5, dc collector ma. = 1		24	34	ohms
With dc collector volts = 10, dc collector ma. = 5		4	8	ohms
Input Capacitance for dc emitter volts = 0.5, dc collector ma. = 0	C_{ib}	-	80	pf
Output Capacitance for dc collector volts = 10, dc emitter ma. = 0	C_{ob}	-	25	pf
Output Conductance at frequency of 1 kc:	h_{ob}			
With dc collector volts = 5, dc collector ma. = 1		0.1	0.5	μ mho
With dc collector volts = 10, dc collector ma. = 5		0.1	1	μ mho

DC-Pulse Forward-Current Transfer Ratio for dc collector-to-emitter volts = 10, pulse duration (μ sec) = 300, duty factor of 0.018, dc collector ma. =	h_{FE}		
10	75	-	
150	100	300	
500	40	-	
DC Forward Current Transfer Ratio:	h_{FE}		
With dc collector-to-emitter volts = 10, dc collector ma. =			
0.01	20	-	
0.1	35	-	
With dc collector-to-emitter volts = 10, dc collector ma. = 10, case temperature ^b of -55° C	35	-	
Small-Signal, Short-Circuit Forward-Current Transfer Ratio:	h_{fe}		
With dc collector-to-emitter volts = 5, dc collector ma. = 1, frequency (kc) = 1 . . .	50	200	
With dc collector-to-emitter volts = 10, dc collector ma. = 5, frequency (kc) = 1 . . .	70	300	
With dc collector-to-emitter volts = 10, dc collector ma. = 50, frequency (Mc) = 20 . . .	3.5	-	
Small-Signal Open-Circuit Reverse Voltage Transfer Ratio at frequency of 1 Kc:	h_{rb}		
With dc collector volts = 5, dc collector ma. = 1	-	5×10^{-4}	
With dc collector volts = 10, dc collector ma. = 5	-	5×10^{-4}	
Noise Figure for signal frequency of 1 kc, circuit bandwidth of 1 cycle, generator resistance (ohms) = 510, dc collector-to-emitter volts = 10, dc collector ma. = 0.3	NF	-	8 db



Thermal Resistance:

Junction-to-case.	θ_{J-C}	-	58.3	$^{\circ}\text{C}/\text{watt}$
Junction-to-free-air. . .	θ_{J-FA}	-	219	$^{\circ}\text{C}/\text{watt}$

^b Measured at center of seating plane.

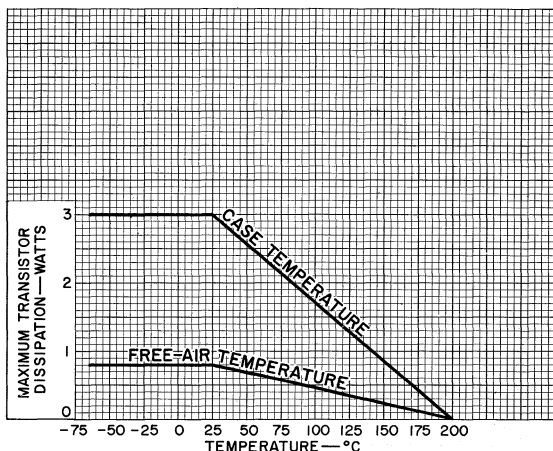
OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

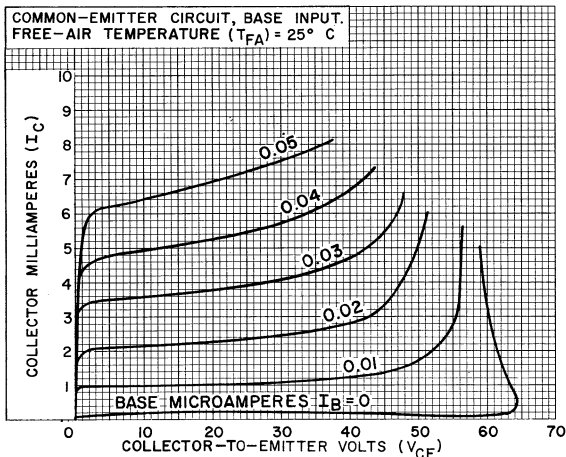
RATING CHART



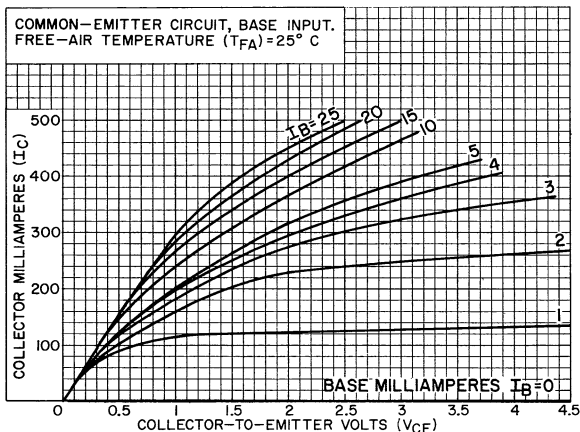
92CS-III73RI



TYPICAL COLLECTOR CHARACTERISTICS



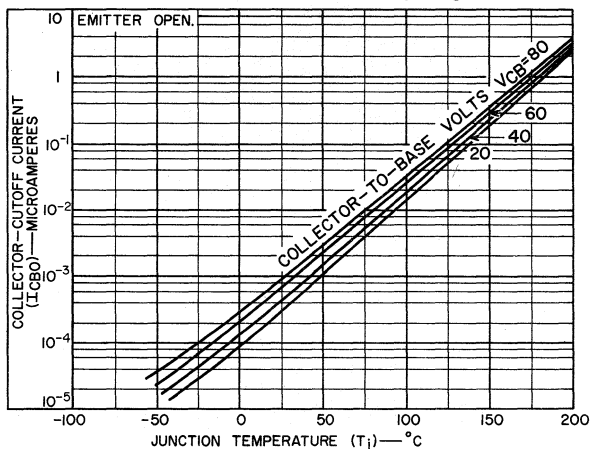
92CS-11630



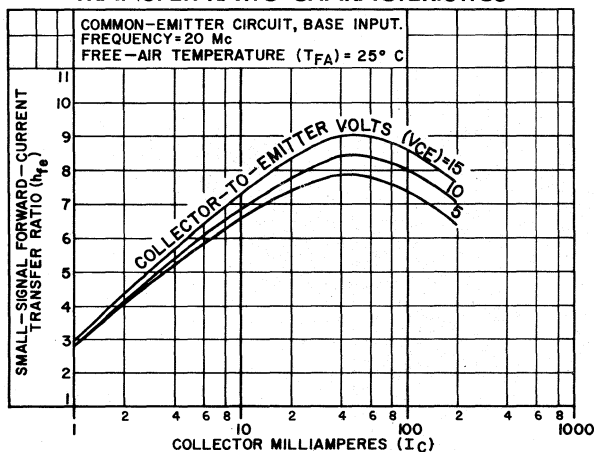
92CS-11631



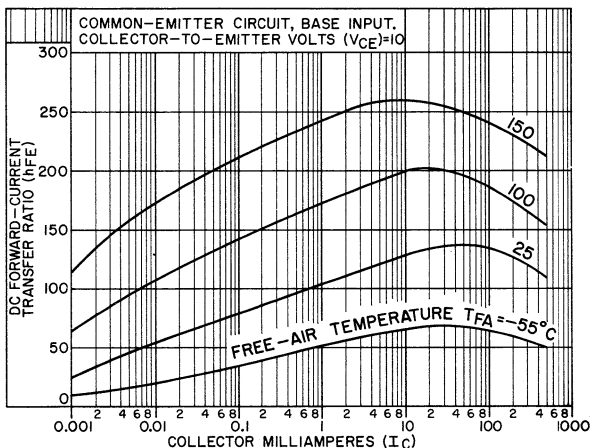
TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS

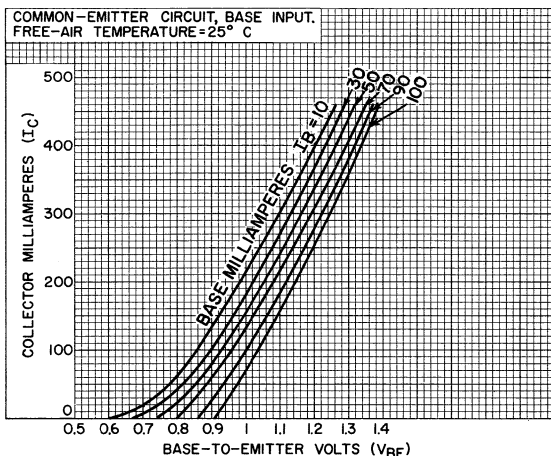


TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



92CS-11629

TYPICAL TRANSFER CHARACTERISTICS

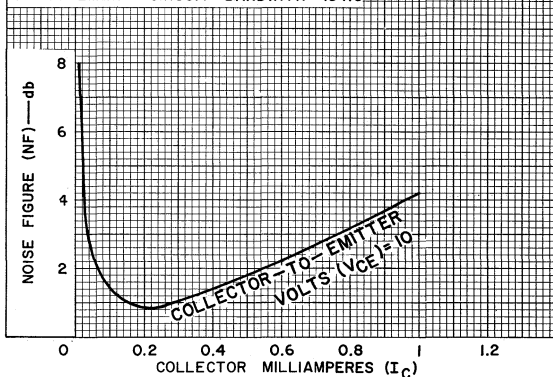


92CS-11185



TYPICAL AF-NOISE-FIGURE CHARACTERISTIC

COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE (T_{FA}) = 25° C
GENERATOR RESISTANCE = 510 OHMS
SIGNAL FREQUENCY = 1 KC
MEASUREMENT - CIRCUIT BANDWIDTH = 15 KC



92CS-11627



Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE

For Industrial Applications

The 2N1769 is the same as the 2N1768 except for the following items:

INDUSTRIAL SERVICE

Such as is dc-to-dc converter, inverter, chopper, voltage- and current-regulator, dc- and servo-amplifier, and relay-actuating circuits

Maximum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	100 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:		
With emitter-to-base reverse biased		
(DC emitter-to-base volts = 1.5) . . .	100 max.	volts
With base open (Sustaining voltage) ^a . .	55 max.	volts

ELECTRICAL CHARACTERISTICS

	Min.	Max.	
Collector-to-Emitter Voltage:			
With emitter reverse bias			
volts = 1.5, dc collector			
ma. = 0.25	V_{CEX}	100	- volts
With base open (Sustaining			
voltage), dc collector			
ma. = 100, dc base			
ma. = 0	V_{CEO}^a (sus)	55	- volts

^a The Collector-to-Emitter Sustaining Voltage ($V_{CEO(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{\alpha M} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).



2N1770 to 2N1778

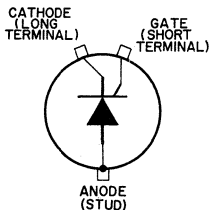
Silicon Controlled-Rectifiers

N-P-N-P ALL-DIFFUSED, 3-JUNCTION TYPE

For Power-Control and Power-Switching Applications Requiring a Blocking-Voltage Capability of 600 Volts and Forward-Current Capability of 4.7 Amperes (Average Value) or 7.4 Amperes (RMS Value)

Mechanical:

Dimensions See accompanying *Dimensional Outline*
Terminal Diagram



The arrow indicates direction of forward current as indicated by dc ammeter.

Maximum Ratings, Absolute-Maximum Values:

Unless otherwise specified, for sinusoidal ac supply voltage operation, at a frequency between 50 and 400 cps, with resistive or inductive load

RCA Type	Peak Reverse Voltage (With gate open)	
	Repetitive- $v_{RM}(\text{rep})^a$	Non-Repetitive- $v_{RM}(\text{non-rep})^b$
	max. volts	(Transient) max. volts
2N1770	25	35
2N1771	50	75
2N1772	100	150
2N1773	150	225
2N1774	200	300
2N1775	250	350
2N1776	300	400
2N1777	400	500
2N1778	500	600

The following values apply to all the rectifiers shown above

Peak Forward Blocking
Voltage (Repetitive). . . $v_{FBOM}(\text{rep})$ 600 max. volts
With gate open



2N1770 to 2N1778

Average Forward Current

At case temperatures

with heat sink:

From -65 to 60° C at

a conduction angle

of 180°

Above 60° C at other

conduction angles. .

I_{FAV} 4.7 max. amp

I_{FAV} See Average-Forward
Current Rating Chart

Peak Surge Current in

single phase, 60 cps,

resistive load operation:

For one cycle of

applied voltage. . . . $i_{FM}(\text{surge})$

60 max. amp

For more than one

cycle of applied

voltage. $i_{FM}(\text{surge})$

See Peak-Surge-
Current Rating Chart

Peak Gate Voltage

(With anode open):

Forward. V_{GKM} 10 max. volts

Reverse. V_{KGM} 10 max. volts

Peak Forward Gate Current.

i_{GKM} 2 max. amp

Peak Gate Power.

P_{GM} 5 max. watts

Average Gate Power

P_{GAV} 0.5 max. watt

Temperature

Operating range (Case)°C.

T_{opr} -65 to 125 °C

Storage range.

T_{stg} -65 to 150 °C

Free air

T_{FA}

See Operation
Guidance Chart

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, at maximum electrical ratings and at indicated case temperatures

RCA Type	Forward Breakover Voltage- V_{B00} ($T_C = 125^\circ\text{C}$)	Average Blocking Current (for complete cycle, gate open, $T_C = 125^\circ\text{C}$)	
		Forward- I_{FBOAV} max. ma	Reverse- I_{RBOAV} max. ma
	min. volts		
2N1770	25	4.5	4.5
2N1771	50	4.5	4.5
2N1772	100	4.5	4.5
2N1773	150	4	4
2N1774	200	3	3
2N1775	250	2.5	2.5
2N1776	300	2	2
2N1777	400	1	1
2N1778	500	1	1



2N1770 to 2N1778

The following values apply to all the rectifiers shown above

	Min.	Typ.	Max.	
Instantaneous Forward				
Voltage Drop. v_f	-	-	1.85	volts
At $i_F = 15$, $T_C = 25^\circ \text{C}$				
DC Gate-Trigger Voltage				
with anode at +6 volts				
with respect to cathode:				
$T_C = -65^\circ \text{ to } +125^\circ \text{C} \dots V_{GT}$	-	-	2	volts
$T_C = +125^\circ \text{C} \dots V_{GT}$	0.3	-	-	volt
DC Gate-Trigger Current				
with anode at +6 volts				
with respect to cathode,				
$T_C = 25^\circ \text{C} \dots I_{GT}$	-	-	15	ma
Holding Current i_{HOO}				
at $T_C = 125^\circ \text{C}$				
With gate open				
-	-	10	-	ma
Thermal Resistance. θ_{JC}				
Junction-to-case				
-	-	-	3.1 ^d	$^\circ\text{C}/\text{watt}$

- a Terms, Symbols, and Definitions for the data given are shown in the General Section of the Handbook.
- b For duration of 5 milliseconds maximum (gate voltage is zero or negative with respect to cathode).
- c Measured at center of any of the six major surfaces on the perimeter of the hexagonal flange.
- d Between junction and any of the six major surfaces on the perimeter of the hexagonal flange.

OPERATING CONSIDERATIONS

Because these rectifiers may operate at voltages which are dangerous, care should be taken in the design of equipment to prevent the operator from coming in contact with the rectifier.

The recommended torque is 15 to 20 inch-pounds applied to 10-32 UNF-2B hex nut assembled on thread.

The applied torque during installation should not exceed 50 inch-pounds.

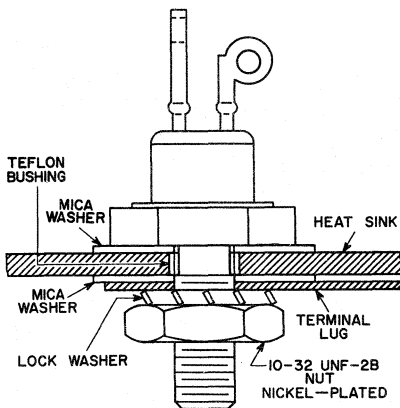


2N1770 to 2N1778

SUGGESTED MOUNTING ARRANGEMENT

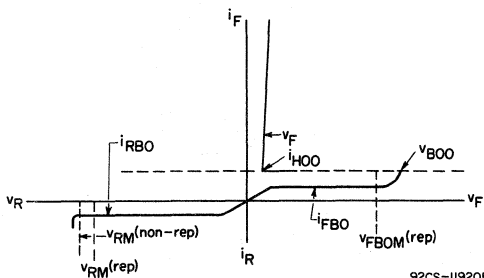
Device Insulated from Heat-Sink

Components shown for mounting (except heat sink) are furnished with each device



92CS-12633

TYPICAL E-I CHARACTERISTIC OF SILICON CONTROLLED-RECTIFIER



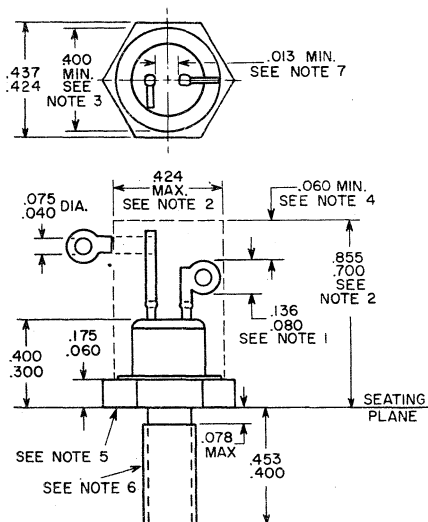
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Electronic Components and Devices

Harrison, N. J.



2N1770 to 2N1778



92CS-12632

DIMENSIONS IN INCHES

Note 1: Contour and orientation of fixed terminal lugs are optional.

Note 2: The outline contour with exception of hexagon is optional within the zone defined by these dimensions.

Note 3: Minimum diameter of seating plane.

Note 4: Minimum difference in terminal lengths to establish datum line for numbering terminals.

Note 5: A chamfer (or undercut) on one or both ends of hexagonal portion is optional.

Note 6: Pitch diameter--thread 10-32 UNF-2A (coated). Ref. (screw thread standards for federal services--Handbook H-28).

Note 7: Minimum spacing between terminals.



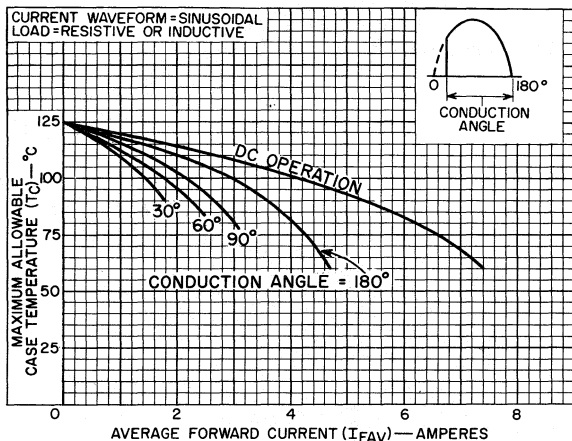
RADIO CORPORATION OF AMERICA
Electronic Components and Devices

Harrison, N. J.

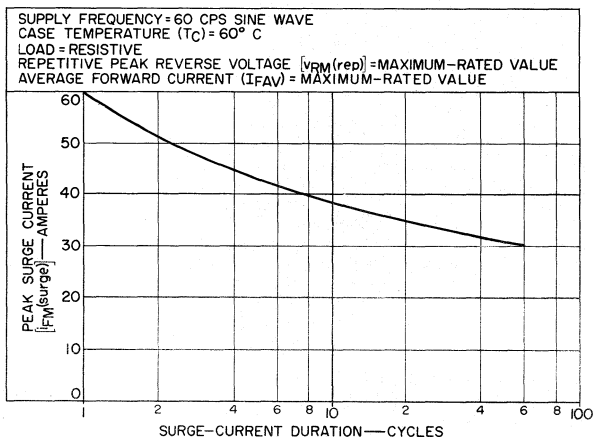
DATA 3
10-64

2N1770 to 2N1778

Average-Forward-Current Rating Chart

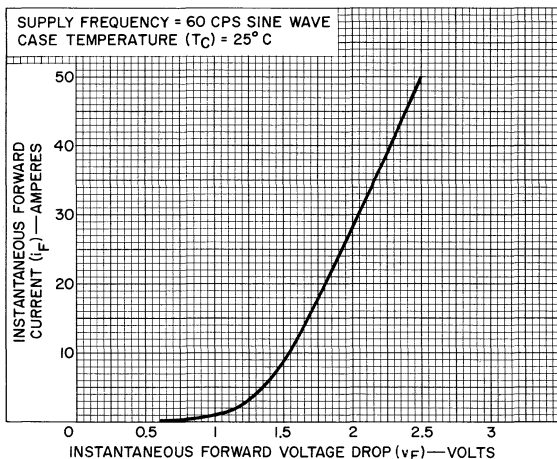


Peak-Surge Current Rating Chart



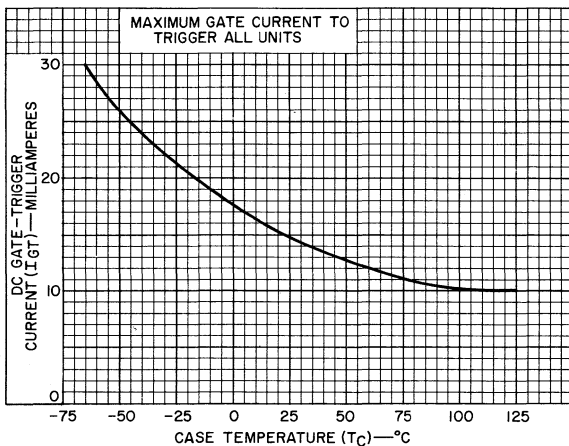
2N1770 to 2N1778

Forward Characteristic



92CS-12629

DC Gate Trigger-Voltage Characteristic



92CS-12631

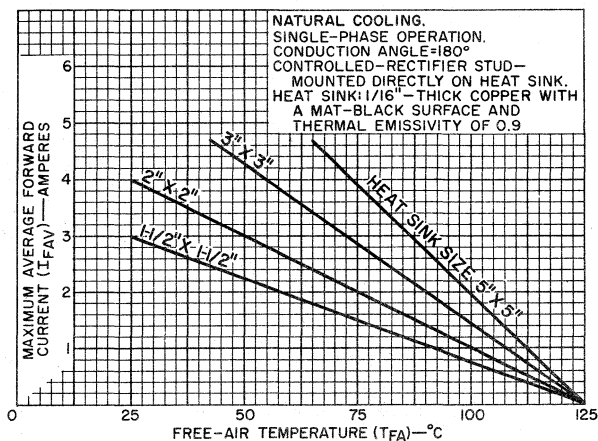


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Electronic Components and Devices
Harrison, N. J.

DATA 4
10-64

2N1770 to 2N1778

Operation Guidance Chart



92CS-12626



Silicon Controlled-Rectifier

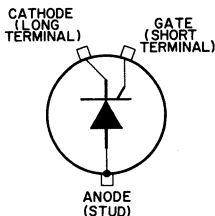
N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications In Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

GENERAL DATA

Mechanical:

Dimensions. See Outline T0-48 in General Section
Terminal Diagram:



The arrow indicates direction of forward (easy) current flow as indicated by dc ammeter.

Maximum and Minimum Ratings, Absolute-Maximum Values:

Unless otherwise specified, for sinusoidal ac supply voltage at a frequency between 50 and 400 cps, with resistive or inductive load

PEAK REVERSE VOLTAGE (With gate open):

Repetitive.	$V_{RM(rep)}$	25 max.	volts
---------------------	---------------	---------	-------

Non-repetitive (Transient)
for duration of 5 milli-

seconds maximum	$V_{RM(non-rep)}$	35 max.	volts
---------------------------	-------------------	---------	-------

PEAK FORWARD BLOCKING VOLTAGE (Repetitive):

With gate open.	$V_{FBOM(rep)}$	25 max.	volts
-------------------------	-----------------	---------	-------

AVERAGE FORWARD CURRENT:

At case temperatures:^a

From -65°C to 80°C
and a conduction angle
of 180°

I_{FAV}	10 max.	amp
-----------	---------	-----

Above 80°C and at other
conduction angles

I_{FAV}	See Average-Forward- Current Rating Chart	
-----------	--	--

PEAK SURGE CURRENT in single-phase, 60 cps, resistive load operation:^b

For one cycle of applied

voltage	$i_{FM(surge)}$	125 max.	amp
-------------------	-----------------	----------	-----



2N1842A

For more than one cycle of applied voltage. . . $i_{FM}(\text{surge})$ See *Peak-Surge-Current Rating Chart*

PEAK GATE VOLTAGE (With anode open):

Forward	V_{GKM}	10 max.	volts
Reverse	V_{KGM}	5 max.	volts
PEAK FORWARD GATE CURRENT . .	i_{GKM}	2 max.	amp
PEAK GATE POWER	P_{GM}	5 max.	watts
AVERAGE GATE POWER.	P_{GAV}	0.5 max.	watt

TEMPERATURE:

Operating (Case) ^a	$T_{C(opr)}$	-65 to 125	°C
Operating (Free-air).	$T_{FA(OPR)}$	See <i>Operation Guidance Chart</i>	
Storage	T_{STG}	-65 to 125	°C

^a Measured at the center of any of the six major faces on the perimeter of the hexagonal flange.

^b Superimposed on device operating within the maximum voltage, average-forward current, gate power, and temperature ratings and may be repeated after sufficient time has elapsed for the device to return to the pre-surge thermal-equilibrium conditions.

ELECTRICAL AND THERMAL CHARACTERISTICS

Unless otherwise specified, at maximum electrical ratings and at indicated case temperatures^a

Min. Typ. Max.

Forward Breakover Voltage at case temperature = 125° C, gate open	V_{BOO}	25	-	-	volts
Average Forward Voltage Drop for one complete cycle in single-phase, 60 cps, resistive load, case temperature = 80° C, gate open. .	V_{FAV}	-	-	1.2	volts
Average Blocking Current for one complete cycle, case temperature = 125° C, gate open:					
Forward	I_{FBOAV}	-	-	22.5	ma
Reverse	I_{RBOAV}	-	-	22.5	ma
DC Gate-Trigger Voltage with anode at +6 volts with respect to cathode, case temperature of:					
-40° C.	V_{GT}	-	-	3.5	volts
-65° C.	V_{GT}	-	-	3.7	volts
125° C.	V_{GT}	0.25	-	-	volt
100° C.	V_{GT}	0.3	-	-	volt
DC Gate-Trigger Current with anode at +6 volts with respect to cathode, case temperature = 125° C. . . .	I_{GT}	-	-	45	ma
Holding Current at case temperature = 125° C, gate open	i_{HOO}	-	8	-	ma



Min. Typ. Max.

Thermal Resistance:

Junction-to-case. θ_{JC} - - - 2° °C/watt

- ^a Measured at center of any of the six major surfaces on the perimeter of the hexagonal flange.
- ^c Between junction and any of the six major surfaces on the perimeter of the hexagonal flange.

OPERATING CONSIDERATIONS

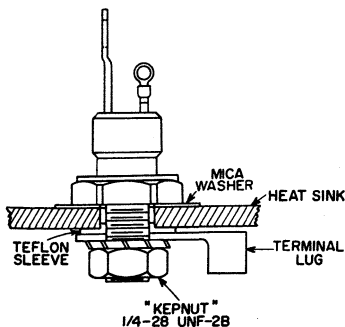
Because this rectifier may operate at voltages which are dangerous, care should be taken in the design of equipment to prevent the operator from coming in contact with the rectifier.

The recommended installation torque is 26 to 36 inch-pounds applied to a 1/4-28 UNF-2B hex nut assembled on stud thread.

The applied torque during installation should not exceed 50 inch-pounds.

SUGGESTED MOUNTING ARRANGEMENT Device Insulated from Heat-Sink

Components shown for mounting (except heat sink) are furnished with each device



92CS-11899R1

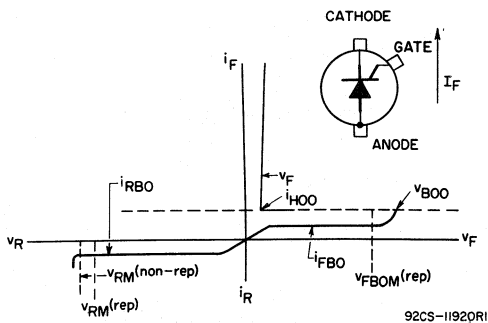


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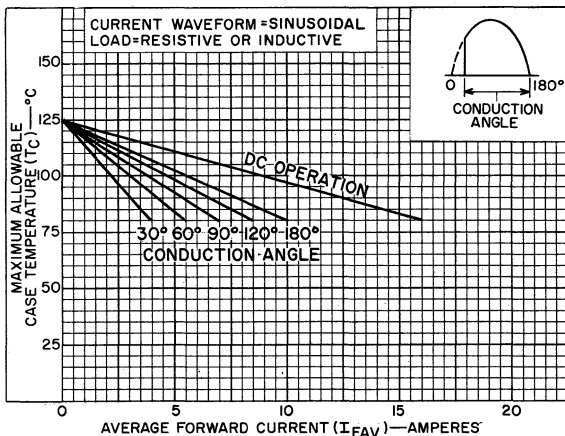
DATA 2
7-63

2N1842A

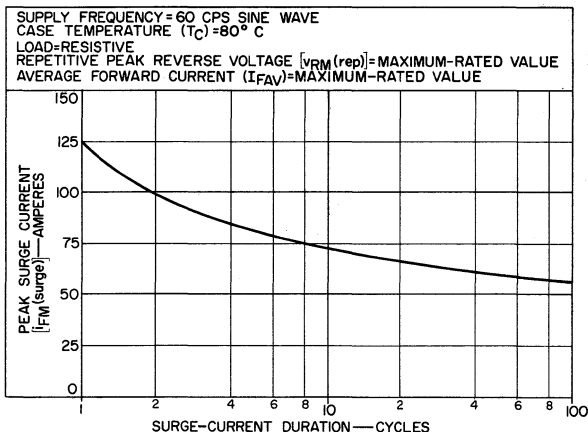
TYPICAL VOLTAGE AND CURRENT CHARACTERISTIC OF SILICON CONTROLLED-RECTIFIER



AVERAGE-FORWARD-CURRENT RATING CHART

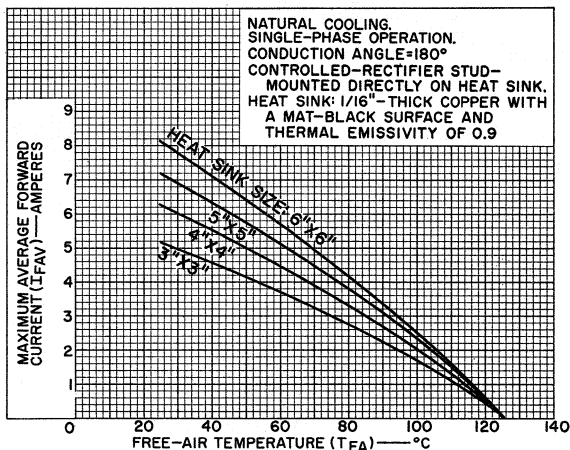


PEAK-SURGE-CURRENT RATING CHART



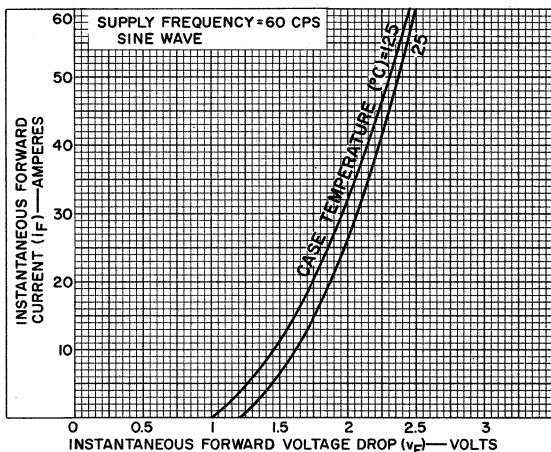
2N1842A

OPERATION GUIDANCE CHART



92CS-11907RI

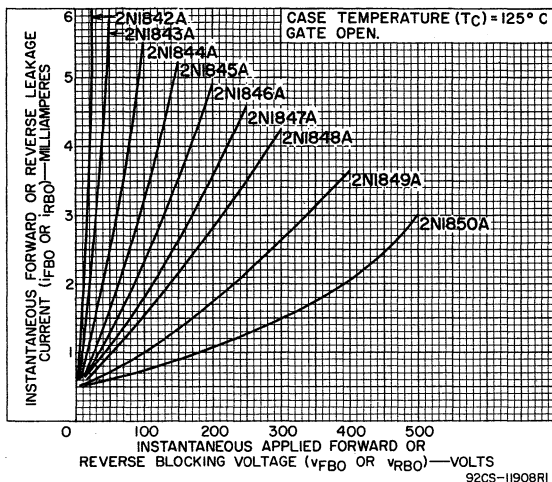
MAXIMUM FORWARD CHARACTERISTICS



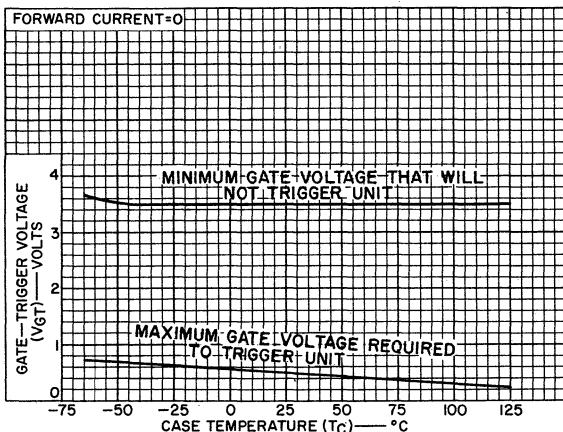
92CS-11912RI



TYPICAL FORWARD AND REVERSE LEAKAGE-CURRENT CHARACTERISTICS

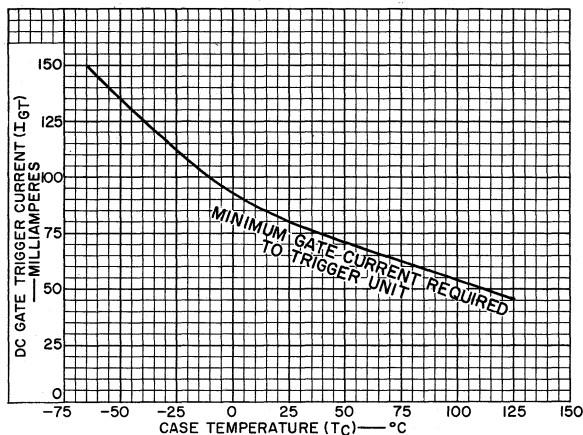


GATE TRIGGER-VOLTAGE CHARACTERISTICS



2N1842A

DC GATE-TRIGGER-CURRENT CHARACTERISTIC



92CS-11906R2



Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N1843A is the same as the 2N1842A except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive. $V_{RM}(rep)$ 50 max. volts

Non-repetitive (Transient) for duration of 5 milliseconds

maximum. $V_{RM}(surge)$ 75 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM}(rep)$ 50 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at

case temperature = 125° C,

gate open. V_{BOO} 50 - - volts

Average Forward Blocking Current for one complete cycle, case temperature = 125° C, gate open:

Forward. I_{FBOAV} - - 19 ma

Reverse. I_{RBOAV} - - 19 ma



Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N1844A is the same as the 2N1842A except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive $V_{RM(rep)}$ 100 max. volts

Non-repetitive (Transient) for duration of 5 milliseconds

maximum $V_{RM(surge)}$ 150 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM(rep)}$ 100 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at

case temperature = 125° C,

gate open V_{BOO} 100 - - volts

Average Forward Blocking

Current for one complete

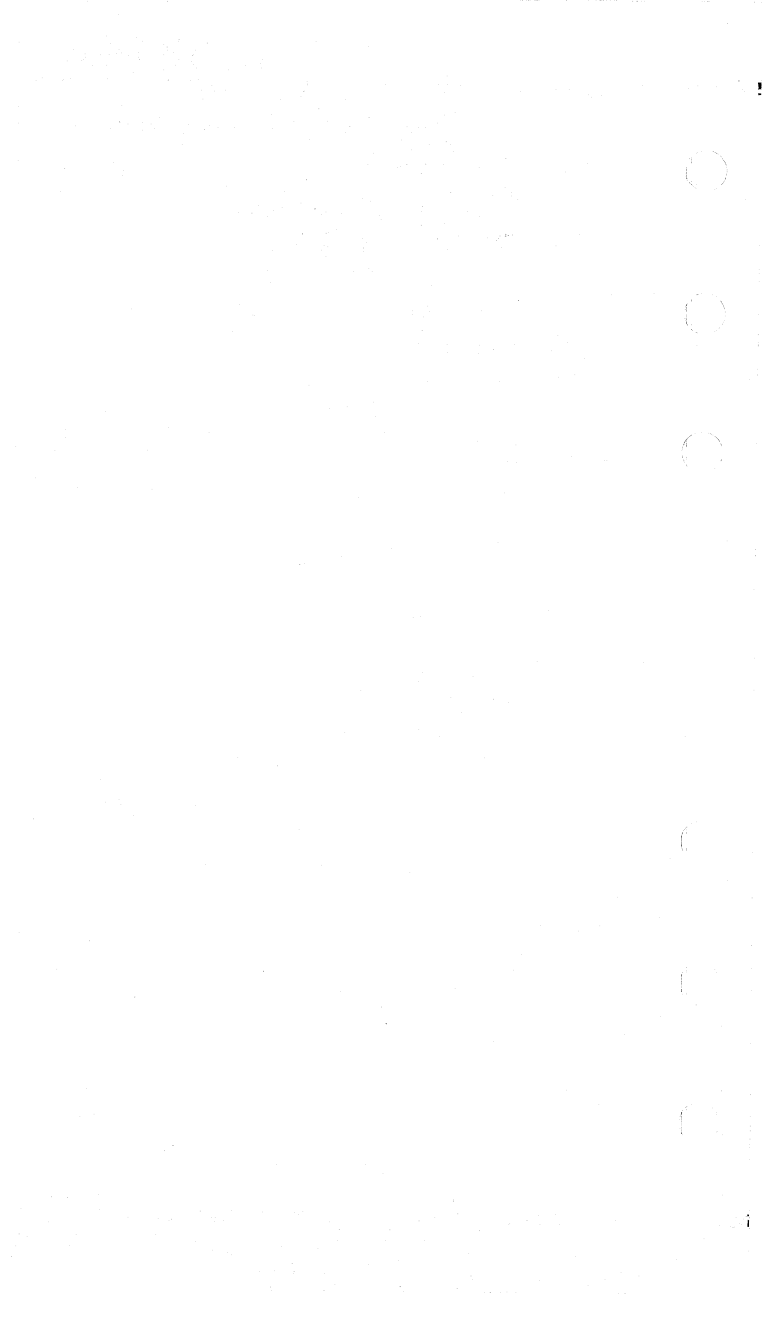
cycle, case temperature

= 125° C, gate open:

Forward I_{FBOAV} - - 12.5 ma

Reverse I_{RBOAV} - - 12.5 ma





Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N1845A is the same as the 2N1842A except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive. $V_{RM(rep)}$ 150 max. volts

Non-repetitive (Transient) for duration of 5 milliseconds

maximum. $V_{RM(surge)}$ 225 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM(rep)}$ 150 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at case temperature = 125° C,

gate open. V_{BOO} 150 - - volts

Average Forward Blocking

Current for one complete

cycle, case temperature

= 125° C, gate open:

Forward. I_{FBOAV} - - 6.5 ma

Reverse. I_{RBOAV} - - 6.5 ma



Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N1846A is the same as the 2N1842A except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive. $V_{RM(rep)}$ 200 max. volts

Non-repetitive (Transient) for duration of 5 milliseconds

maximum. $V_{RM(surge)}$ 300 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM(rep)}$ 200 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at case temperature = 125° C,

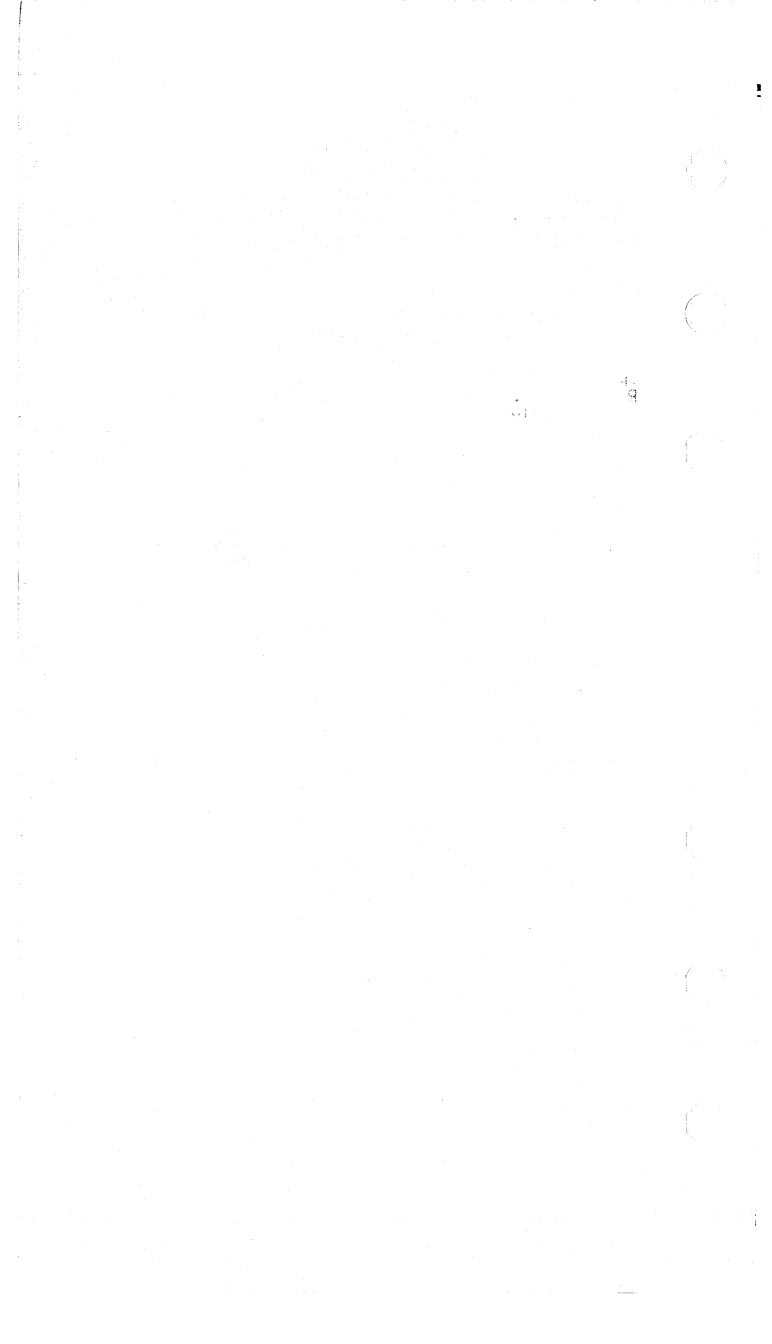
gate open. V_{BOO} 200 — — volts

Average Forward Blocking Current for one complete cycle, case temperature = 125° C, gate open:

Forward. I_{FBOAV} — — 6 ma

Reverse. I_{RBOAV} — — 6 ma





Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N1847A is the same as the 2N1842A except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive $V_{RM(rep)}$ 250 max. volts

Non-repetitive (Transient) for duration of 5 milliseconds

maximum $V_{RM(surge)}$ 350 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open $V_{FBOM(rep)}$ 250 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at

case temperature = 125° C,

gate open V_{BOO} 250 - - volts

Average Forward Blocking

Current for one complete

cycle, case temperature

= 125° C, gate open:

Forward I_{FBOAV} - - 5.5 ma

Reverse I_{RBOAV} - - 5.5 ma



Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N1848A is the same as the 2N1842A except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive. $V_{RM(rep)}$ 300 max. volts

Non-repetitive (Transient) for duration of 5 milliseconds

maximum $V_{RM(surge)}$ 400 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM(rep)}$ 300 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at case temperature = 125° C,

gate open V_{BOO} 300 - - volts

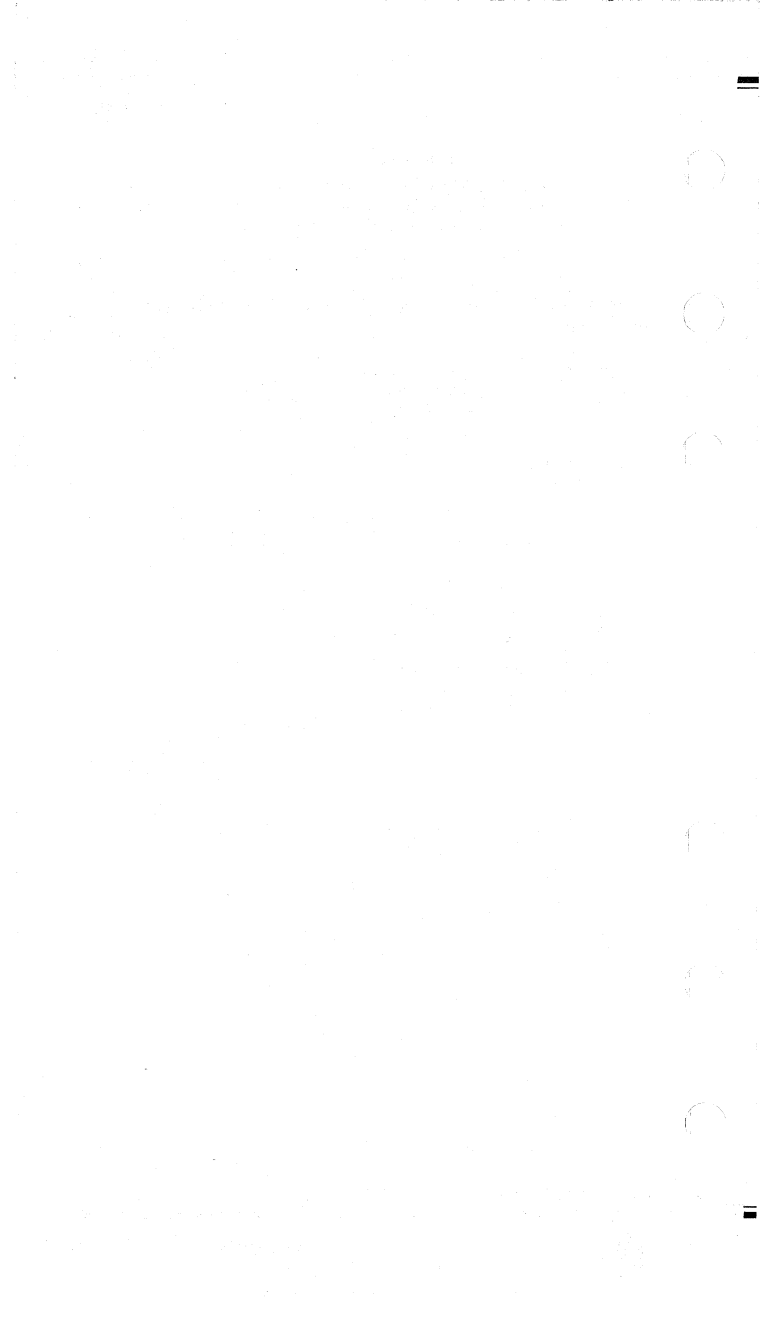
Average Forward Blocking

Current for one complete cycle, case temperature = 125° C, gate open:

Forward I_{FBOAV} - - 5 ma

Reverse I_{RBOAV} - - 5 ma





Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N1849A is the same as the 2N1842A except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate

open):

Repetitive $V_{RM(rep)}$ 400 max. volts

Non-repetitive (Transient) for

duration of 5 milliseconds

maximum $V_{RM(surge)}$ 500 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM(rep)}$ 400 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at

case temperature = 125° C,

gate open V_{BOO} 400 — — volts

Average Forward Blocking

Current for one complete

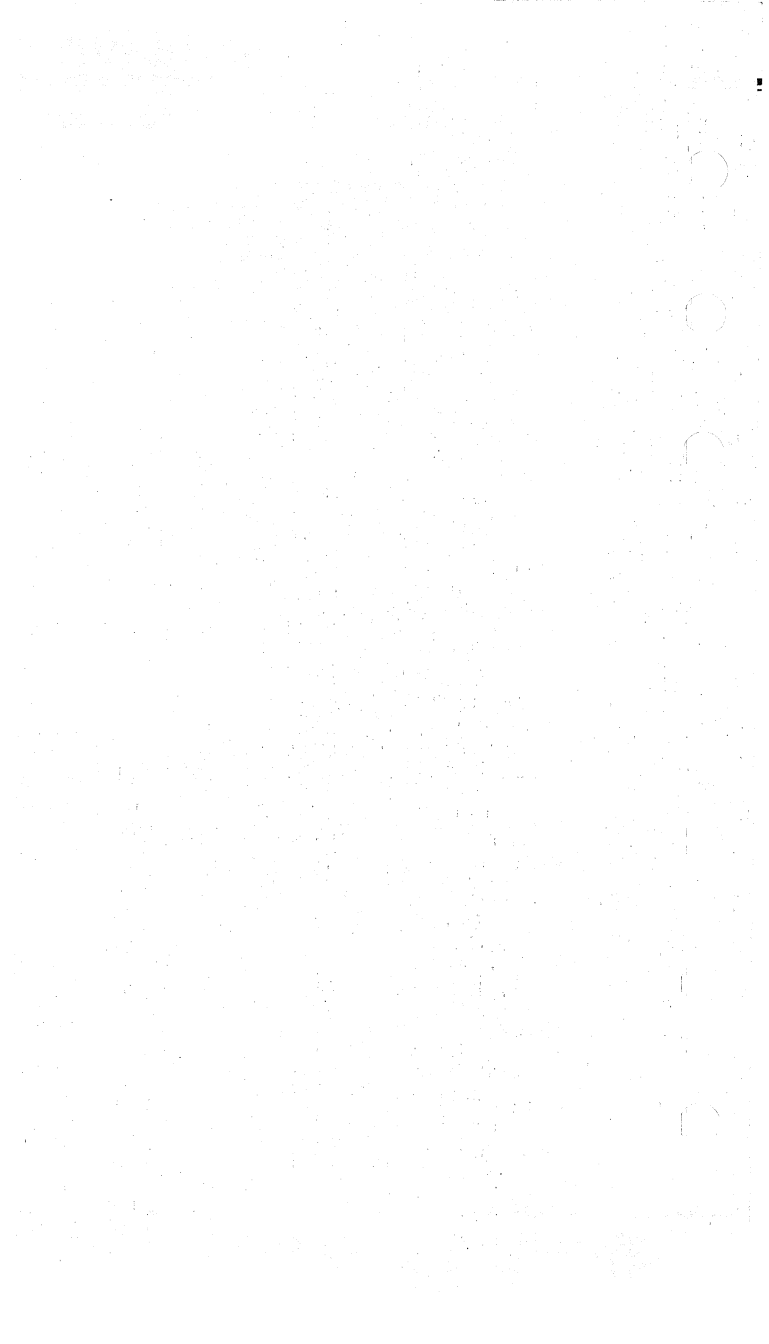
cycle, case temperature

= 125° C, gate open:

Forward I_{FBOAV} — — 4 ma

Reverse I_{RBOAV} — — 4 ma





Silicon Controlled-Rectifier

N-P-N-P DIFFUSED-JUNCTION TYPE

For Power-Control and Power-Switching Applications in Industrial and Military Equipment. Designed to Meet Stringent Military Environmental and Mechanical Specifications.

The 2N1850A is the same as the 2N1842A except for the following items:

Maximum and Minimum Ratings, Absolute-Maximum Values:

PEAK REVERSE VOLTAGE (With gate open):

Repetitive $V_{RM(rep)}$ 500 max. volts

Non-repetitive (Transient) for

duration of 5 milliseconds

maximum $V_{RM(surge)}$ 600 max. volts

PEAK FORWARD BLOCKING VOLTAGE

(Repetitive):

With gate open. $V_{FBOM(rep)}$ 500 max. volts

ELECTRICAL AND THERMAL CHARACTERISTICS

Min. Typ. Max.

Forward Breakover Voltage at

case temperature = 125° C,

gate open V_{BOO} 500 - - volts

Average Forward Blocking

Current for one complete

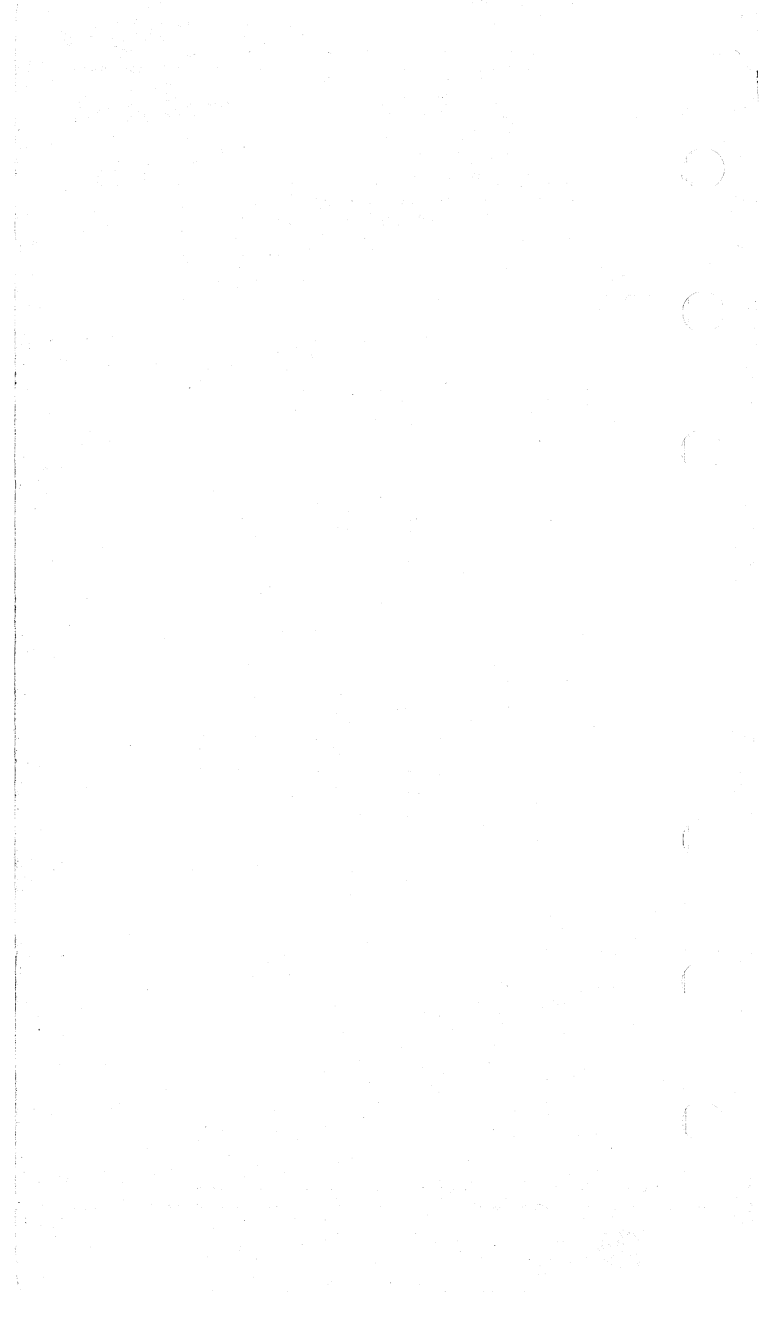
cycle, case temperature

= 125° C, gate open:

Forward I_{FBOAV} - - 3 ma

Reverse I_{RBOAV} - - 3 ma





Transistor

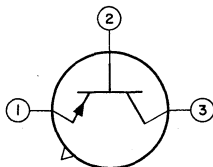
GERMANIUM P-N-P DIFFUSED-JUNCTION MESA TYPE
For High-Speed Saturated Switching Applications
in Commercial and Military Data-Processing Systems

GENERAL DATA

Mechanical:

Dimensions. See Outline TO-5 in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} -18 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With base open. V_{CEO} -6 max. volts

EMITTER-TO-BASE VOLTAGE:^a

With collector open V_{EB0} -2 max. volts

COLLECTOR CURRENT I_C -100 max. ma

TRANSISTOR DISSIPATION:^b

At free-air temperature of
25° C or below. P 150 max. mw

EMITTER-TO-BASE DISSIPATION:

With emitter-to-base reverse bias
dc volts = -2, free-air temperature
of 25° C or below 25 max. mw

FREE-AIR TEMPERATURE RANGE:

Junction (Operating). T_J -55 to +85 °C

Storage T_{STG} -55 to +85 °C

LEAD TEMPERATURE:^c

For 10 seconds maximum. T_L 235 max. °C

^a This rating may be exceeded and the emitter-to-base junction operated in the breakdown condition provided the emitter-to-base dissipation is limited to 25 milliwatts at 25° C. For free-air temperatures above 25° C, reduce the dissipation.

^b See accompanying Rating Chart and Transistor-Dissipation Rating Chart in General Section.

^c Measured 1/16" ± 1/32" along lead, down from seating plane.



ELECTRICAL CHARACTERISTICS

Unless otherwise specified, free-air temperature = 25° C

Min. Max.

DC Collector-to-Base Breakdown				
Voltage for dc collector ma. = -0.025, dc emitter current = 0.				
	BV _{CBO}	-18	-	volts
DC Collector-to-Emitter Breakdown Voltage for base-to-emitter reverse bias dc volts = -0.15, dc collector ma. = -0.025				
	BV _{CEV}	-18	-	volts
DC Emitter-to-Base Breakdown				
Voltage for dc emitter ma. = -0.1, dc collector current = 0.				
	BV _{EBO}	-2	-	volts
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = -6, dc base ma. = -0.2				
	V _{CE(sat)}	-	-0.2	volt
DC Base-to-Emitter Voltage for dc collector ma. = -6, dc base ma. = -0.2				
	V _{BE}	-	-0.4	volt
DC Collector-Cutoff Current:				
With dc collector-to-base volts = -15, dc emitter current = 0.				
	I _{CBO}	-	-4.2	μa
With dc collector-to-base volts = -18, dc emitter current = 0, free-air temperature = 60.				
		-	-35	μa
DC Emitter-Cutoff Current for dc emitter-to-base volts = -2, dc collector current = 0				
	I _{EBO}	-	-100	μa
DC Forward-Current Transfer Ratio:				
With dc collector-to-emitter volts = -1, dc base ma. = -0.2				
	h _{FE}	30	400	
With dc collector-to-emitter volts = -0.4, dc collector ma. = -6				
		30	-	
Switching Time:				
Turn-on time ^d				
	t _{on}	-	0.8	μsec
Turn-off time ^e				
	t _{off}	-	0.9	μsec
Storage time ^e				
	t _s	-	0.8	μsec

^d See accompanying Turn-On-Time (t_{on}) Measurement Circuit.

^e See accompanying Turn-Off-Time (t_{off}) and Storage-Time (t_s) Measurement Circuit.

OPERATING CONSIDERATIONS

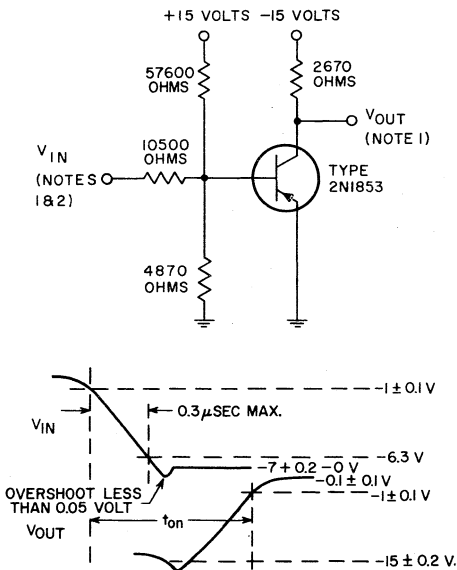
It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The flexible leads of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct

excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board, and to prevent the base from shorting to ground.

TURN-ON-TIME MEASUREMENT CIRCUIT AND ASSOCIATED WAVE FORMS



92CS-11717

NOTE 1: INPUT AND OUTPUT WAVE FORMS (V_{IN} AND V_{OUT}) SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME OF LESS THAN 15 NANoseconds, A PROBE CAPACITANCE OF NOT MORE THAN 12 PF, AND A SHUNT RESISTANCE OF NOT LESS THAN 10 MEGOHMS.

NOTE 2: INPUT VOLTAGE (V_{IN}) OBTAINED FROM A MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 100 OHMS.

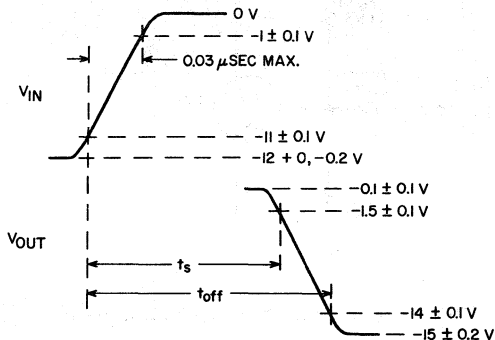
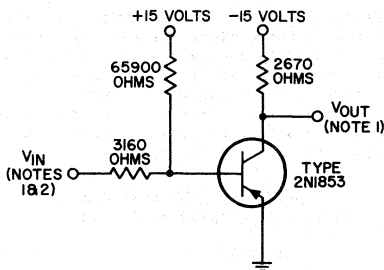


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Semiconductor & Materials Division Somerville, N. J.

DATA 2
8-62

2N1853

TURN-OFF-TIME AND STORAGE-TIME MEASUREMENT CIRCUIT AND ASSOCIATED WAVE FORMS



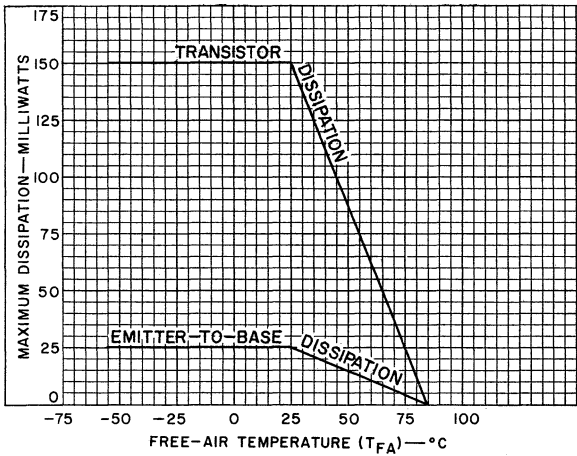
92CS-11718

NOTE 1: INPUT AND OUTPUT WAVE FORMS (V_{IN} AND V_{OUT}) SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME OF LESS THAN 15 NANoseconds, A PROBE CAPACITANCE OF NOT MORE THAN 12 PF, AND A SHUNT RESISTANCE OF NOT LESS THAN 10 MEGOHMS.

NOTE 2: INPUT VOLTAGE (V_{IN}) OBTAINED FROM A MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 100 OHMS.



RATING CHART



92CS 11714



Transistor

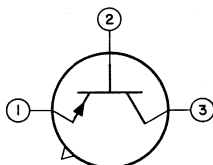
GERMANIUM P-N-P DIFFUSED-JUNCTION MESA TYPE
For High-Speed Saturated Switching Applications
in Commercial and Military Data-Processing Systems

GENERAL DATA

Mechanical:

Dimensions. See *Outline T0-5* in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1—Emitter
Lead 2—Base



Lead 3—Collector

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CBO}	-18 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open.	V_{CEO}	-6 max.	volts
EMITTER-TO-BASE VOLTAGE: ^a			
With collector open	V_{EB0}	-2 max.	volts
COLLECTOR CURRENT			
	I_C	-100 max.	ma
TRANSISTOR DISSIPATION: ^b			
At free-air temperature of			
25° C or below.	P	150 max.	mw
EMITTER-TO-BASE DISSIPATION:			
With emitter-to-base reverse			
bias dc volts = -2, free-air			
temperature of 25° C or below. .		25 max.	mw
FREE-AIR TEMPERATURE RANGE:			
Junction (Operating).	T_J	-55 to +85	°C
Storage	T_{STG}	-55 to +85	°C
LEAD TEMPERATURE: ^c			
For 10 seconds maximum.	T_L	235 max.	°C

^a This rating may be exceeded and the emitter-to-base junction operated in the breakdown condition provided the emitter-to-base dissipation is limited to 25 milliwatts at 25° C. For free-air temperatures above 25° C, reduce the dissipation.

^b See accompanying *Rating Chart* and *Transistor-Dissipation Rating Chart* in General Section.

^c Measured 1/16" ± 1/32" along lead, down from seating plane.



2N1854

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, free-air temperature = 25° C

Min. Max.

DC Collector-to-Base Breakdown Voltage for dc collector ma. = -0.025, dc emitter current = 0	BV_{CBO}	-18	-	volts
DC Collector-to-Emitter Breakdown Voltage for base-to-emitter reverse bias dc volts = -0.2, dc collector ma. = -0.025 . .	BV_{CEV}	-18	-	volts
DC Emitter-to-Base Breakdown Voltage for dc emitter ma. = -0.1, dc collector current = 0	BV_{EBO}	-2	-	volts
DC Collector-to-Emitter Latching Voltage ^d for dc collector supply volts = -18, emitter-to-base resistance (ohms) = 1000, load resistance (ohms) = 178 . . .	V_{CERL}	-17	-	volts
DC Collector-to-Emitter Saturation Voltage:	$V_{CE(sat)}$			
With dc collector ma. = -20, dc base ma. = -0.66		-	-0.25	volt
With dc collector ma. = -20, dc base ma. = -0.5		-	-0.3	volt
With dc collector ma. = -80, dc base ma. = -2.7, free-air temperature = 55° C		-	-0.7	volt
DC Base-to-Emitter Voltage for dc collector ma. = -20, dc base ma. = -0.5	V_{BE}	-	-0.8	volt
DC Collector-Cutoff Current:	I_{CBO}			
With dc collector-to-base volts = -15, dc emitter current = 0, free-air temperature =				
25° C		-	-4.2	μa
65° C		-	-40	μa
DC Emitter-Cutoff Current for dc emitter-to-base volts = -2, dc collector current = 0 . .	I_{EBO}	-	-100	μa
Output Capacitance for dc collector-to-base volts = -10, dc emitter current = 0	C_{ob}	-	12	pf
DC Forward-Current Transfer Ratio:	h_{FE}			
With dc collector-to-emitter volts = -0.5, dc collector ma. = -20		40	-	
With dc collector-to-emitter volts = -0.75, dc collector ma. = -100		25	-	
With dc collector-to-emitter volts = -1, dc collector ma. = -50		-	400	



Gain-Bandwidth Product for dc
collector-to-emitter volts =
-1, dc collector ma. = -10,
small-signal short-circuit
forward-current transfer
ratio = 5

f_T 40 - Mc

Charge Storage Time:^e

t_{QS}

With dc collector ma. = -20,
turn-on dc base ma. = -1.5.
With dc collector ma. = -80,
turn-on dc base ma. = -4.5.

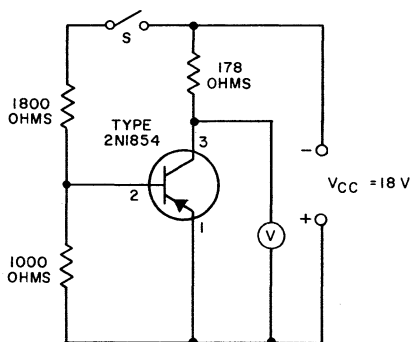
- 60 nsec

- 80 nsec

^d See accompanying *Collector-to-Emitter Latching-Voltage Measurement Circuit.*

^e See accompanying *Charge-Storage-Time Measurement Circuit.*

COLLECTOR-TO-EMITTER LATCHING-VOLTAGE MEASUREMENT CIRCUIT



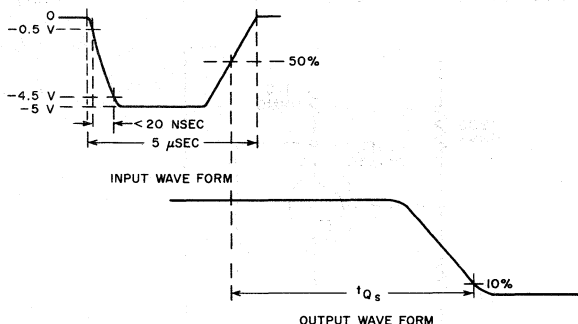
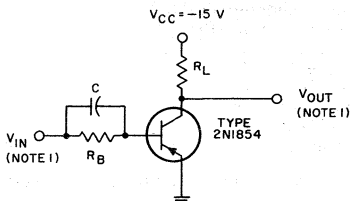
92CS 11715RI

THE TRANSISTOR IS INSERTED IN THE CIRCUIT WITH SWITCH (S) OPEN. THE SWITCH IS THEN CLOSED AND IMMEDIATELY REOPENED. THE RESULTING COLLECTOR-TO-EMITTER VOLTAGE IS THE "LATCHING" VOLTAGE, V_{CERL} .



2N1854

CHARGE-STORAGE-TIME MEASUREMENT CIRCUIT AND ASSOCIATED WAVE FORMS



92CS 11720

For dc collector ma. = -20

C: 150 pf

I_{B1} : Turn-on dc base ma. = -1.5

R_B : 3300 ohms

R_L : 750 ohms

For dc collector ma. = -80

C: 510 pf

I_{B1} : Turn-on dc base ma. = -4.5

R_B : 1100 ohms

R_L : 189 ohms

NOTE 1: INPUT AND OUTPUT WAVE FORMS (V_{IN} AND V_{OUT}) SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME OF LESS THAN 15 NANoseconds, A PROBE CAPACITANCE OF NOT MORE THAN 12 PF, AND A SHUNT RESISTANCE OF NOT LESS THAN 10 MEGOHMS.

OPERATING CONSIDERATIONS and

RATING CHART

shown under type 2N1853 also apply to the 2N1854



Transistor

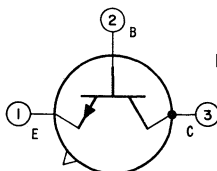
SILICON N-P-N TRIPLE-DIFFUSED-JUNCTION PLANAR TYPE
For Small-Signal and Medium Power Applications in Industrial and Military Equipment

GENERAL DATA

Mechanical:

Dimensions See Outline TO-5 in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1—Emitter
Lead 2—Base



Lead 3—Collector,
Case

INDUSTRIAL SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open.	V_{CBO}	120 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance (ohms) = 10.	V_{CER}	100 max.	volts
With base open.	V_{CEO}	80 max.	volts
EMITTER-TO-BASE VOLTAGE:			
With collector open.	V_{EBO}	7 max.	volts
COLLECTOR CURRENT.	I_C	0.5 max.	amp
TRANSISTOR DISSIPATION:			
At case temperatures: ^a			
From -65° to 25° C.		3 max.	watts
Above 25° C.	Derate linearly 0.0172 watt/°C		
At free-air temperatures:			
From -65° to 25° C.		0.8 max.	watt
Above 25° C.	Derate linearly 0.0046 watt/°C		
TEMPERATURE:			
Operating range (Junction)	T_{opr}	-65 to 200	°C
Storage range.	T_{stg}	-65 to 300	°C
Lead: ^b			
For 10 seconds maximum.	T_l	255 max.	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, case temperature $\bar{a} = 25^\circ\text{C}$

	Min.	Max.	
DC Collector-to-Base Breakdown Voltage for dc collector ma. = 0.1, emitter current = 0.			
	BV_{CBO}	120	volts



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Electronic Components and Devices Harrison, N. J.

DATA 1
9-63

		Min.	Max.	
DC Emitter-to-Base Breakdown Voltage for dc emitter ma. = 0.1, collector current = 0 . . .	BV_{EBO}	7	-	volts
DC Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (ohms) = 10, pulsed-dc collector ma. = 100 ^c	$V_{CER(sus)}$	100	-	volts
With base open, pulsed-dc collector ma. = 30 ^c	$V_{CEO(sus)}$	80	-	volts
DC Base-to-Emitter Saturation Voltage: With pulsed-dc collector ma. = 150 ^c , pulsed-dc base ma. = 15 ^c	$V_{BE(sat)}$	-	1.3	volts
With pulsed-dc collector ma. = 50 ^c , pulsed-dc base ma. = 5 ^c	$V_{BE(sat)}$	-	0.9	volt
DC Collector-to-Emitter Saturation Voltage: With pulsed-dc collector ma. = 150 ^c , pulsed-dc base ma. = 15 ^c	$V_{CE(sat)}$	-	5	volts
With pulsed-dc collector ma. = 50 ^c , pulsed-dc base ma. = 5 ^c	$V_{CE(sat)}$	-	1.2	volts
DC Collector-Cutoff Current for dc collector-to-base volts = 90, emitter current = 0, case temperature (°C) = 25	I_{CBO}	-	0.01	μa
150	I_{CBO}	-	15	μa
DC Emitter-Cutoff Current for dc emitter-to-base volts = 5, collector current = 0	I_{EBO}	-	0.01	μa
Input Impedance at frequency (kc) = 1: With dc collector-to- base volts = 5, dc collector ma. = 1	h_{ib}	20	30	ohms
With dc collector-to- base volts = 10, dc collector ma. = 5	h_{ib}	4	8	ohms
Input Capacitance for dc emitter-to-base volts = 0.5, collector current = 0	C_{ib}	-	85	pf

		Min.	Max.	
Output Capacitance for dc collector-to-base volts = 10, emitter current = 0	C_{ob}	-	15	pf
Output Conductance at frequency (kc) = 1: With dc collector-to-base volts = 5, dc collector ma. = 1	h_{ob}	-	0.5	μ mho
With dc collector-to-base volts = 10, dc collector ma. = 5	h_{ob}	-	0.5	μ mho
DC Forward-Current Transfer Ratio for dc collector-to-emitter volts = 10, dc collector ma. =				
0.1	h_{FE}	20	-	
10 (Pulsed) ^a	h_{FE}	35	-	
150 (Pulsed) ^a	h_{FE}	40	120	
10 (Pulsed) ^a , case temperature ($^{\circ}$ C) = -55 . .	h_{FE}	20	-	
Small-Signal Short-Circuit Forward-Current Transfer Ratio: With dc collector-to-emitter volts = 5, dc collector ma. = 1, frequency (kc) = 1	h_{fe}	30	100	
With dc collector-to-emitter volts = 10, dc collector ma. = 5, frequency (kc) = 1	h_{fe}	45	-	
With dc collector-to-emitter volts = 10, dc collector ma. = 50, frequency (Mc) = 20 . . .	h_{fe}	2.5	-	
Small-Signal Open-Circuit Reverse Voltage Transfer (Feedback) Ratio at frequency (kc) = 1: With dc collector-to-base volts = 5, dc collector ma. = 1	h_{rb}	-	0.000125	
With dc collector-to-base volts = 10, dc collector ma. = 5	h_{rb}	-	0.00015	
Thermal Resistance:				
Junction-to-case	θ_{JC}	-	58.3	$^{\circ}$ C/watt
Junction-to-free-air	θ_{JFA}	-	219	$^{\circ}$ C/watt

^a Measured at center of seating plane.

^b Measured $1/16" \pm 1/32"$ along lead from seating plane.

^c Pulse duration of 300 μ sec, duty factor of 0.02.



OPERATING CONSIDERATIONS

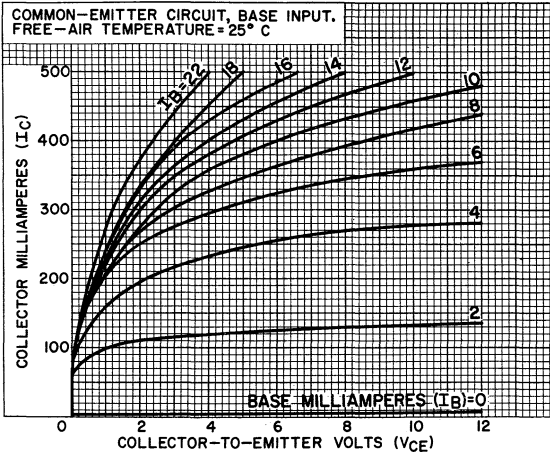
This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

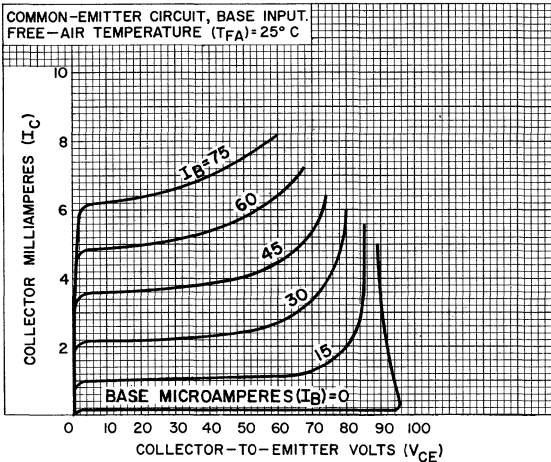
It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



TYPICAL COLLECTOR CHARACTERISTICS



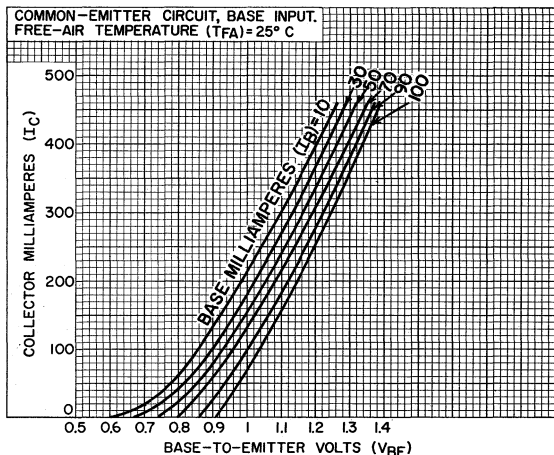
92CS-12076



92CS 11653

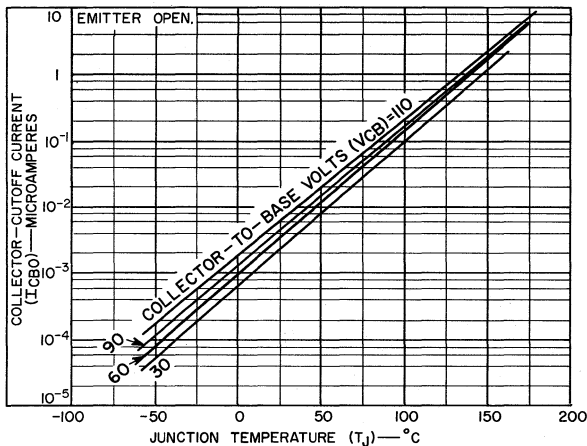


TYPICAL TRANSFER CHARACTERISTICS



92CS-11185

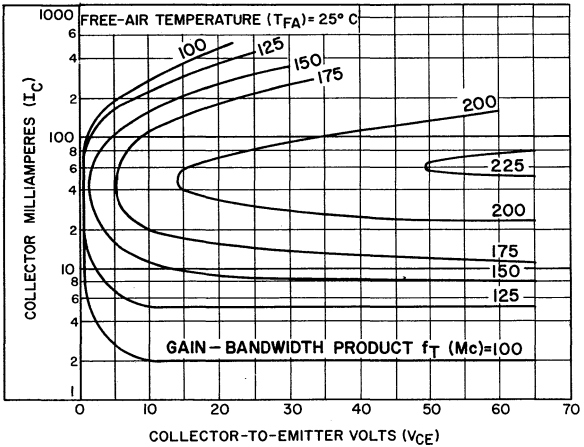
TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



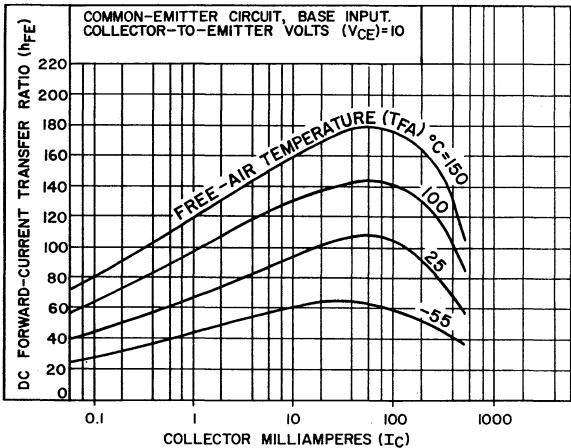
92CS-11170R1



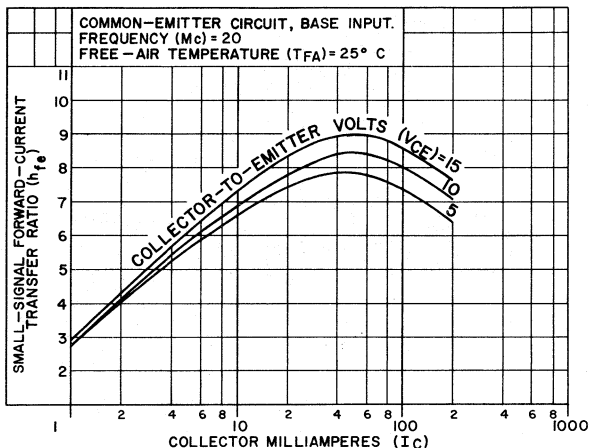
TYPICAL GAIN-BANDWIDTH-PRODUCT CHARACTERISTICS



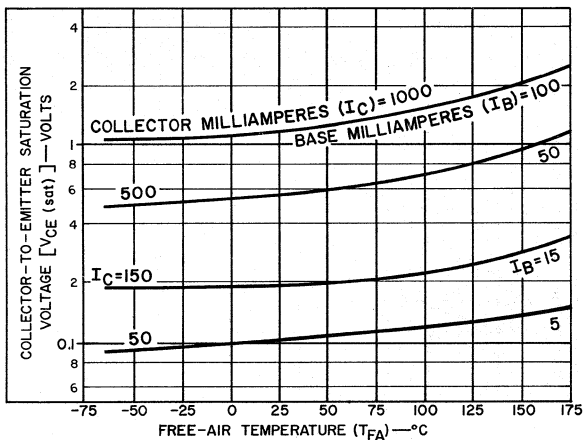
TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



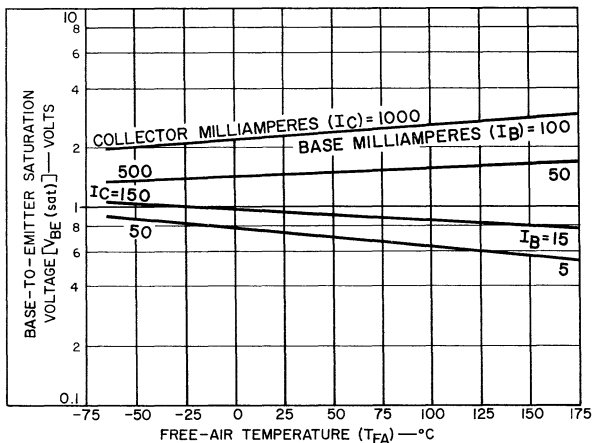
TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



TYPICAL COLLECTOR-TO-EMITTER SATURATION-VOLTAGE CHARACTERISTICS

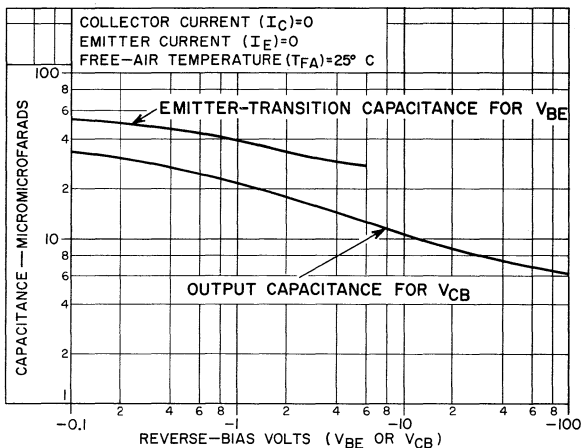


TYPICAL BASE-TO-EMITTER SATURATION-VOLTAGE CHARACTERISTICS



92CS 11651

TYPICAL CAPACITANCE CHARACTERISTICS



92CS-11195



Power Transistor

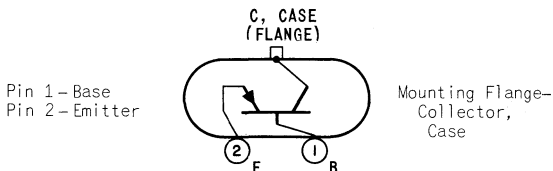
GERMANIUM P-N-P DRIFT-FIELD TYPE

*For Use in Power-Switching Circuits, DC-to-DC Converters,
Inverters, Ultrasonic Oscillators, and Large-Signal
Wide-Band Linear Amplifiers*

MECHANICAL

Dimensions See accompanying *Dimensional Outline*

TERMINAL DIAGRAM (Bottom View)



ABSOLUTE-MAXIMUM RATINGS

Collector-to-Base Voltage.	V_{CB0}	-100	V
Collector-to-Emitter Voltage.	V_{CE0}	-50	V
Emitter-to-Base Voltage.	V_{EB0}	-1.5	V
Collector Current.	I_C	-6	A
Emitter Current.	I_E	6	A
Base Current.	I_B	-1	A

Transistor Dissipation

At mounting-flange temperatures:^a

From -55 to 55°C P_T 30 W

Above 55°C Derate linearly to 0 W at 100°C

Temperature Range

Operating (Junction) T_{opr} -65 to 100 °C

Storage. T_{stg} -65 to 100 °C

Pin-Soldering Temperature^b 255 °C

For 10 s max

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode voltage and electrode-current values for given test conditions are dc at mounting-flange temperature^a = 25°C

Collector-to-Emitter Sustaining

Voltage $V_{CE0}(sus)$ -50 min V

$I_C = -100$ mA, $I_B = 0$

Collector-to-Emitter Saturation

Voltage $V_{CE}(sat)$ -1 max V

$I_C = -5$ A, $I_B = 0.25$ A

Base-to-Emitter Voltage.

V_{BE} -0.5 max V

$V_{CE} = -2$ V, $I_C = -1$ A

Collector-Cutoff Current:

$V_{CB} = -100$ V, V_{BE} (floating) = 1 V. I_{CB0} -10 max mA

$V_{CE} = -40$ V, $V_{BE} = -1$ V, $T_{MF} = 55$ °C. I_{CEV} -3 max mA

$V_{CE} = -40$ V, $I_B = 0$ I_{CE0} -75 max mA

← Indicates a change.



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DATA 1
2-66

2N1905

Emitter-Cutoff Current 1EBO -2.5 max mA

$V_{EB} = 1.5V, I_C = 0$

Static Forward-Current Transfer Ratio

$V_{CE} = -2V, I_C = -5A$ h_{FE} 30 min

$V_{CE} = -2V, I_C = -1A$ h_{FE} 50 to 150

Small-Signal Forward-Current Transfer Ratio

$f = 1 \text{ kc/s}, V_{CE} = -5V, I_C = -0.5 A$ h_{fe} 30 to 200

$f = 1 \text{ Mc/s}, V_{CE} = -5V, I_C = -0.5 A$ h_{fe} 2 min

^a Measured at center of seating surface.

^b Measured $1/16 \pm 1/32$ inch down from plane of seating surface.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

This transistor utilizes the Loranger Mfg. Corp. socket No. 2149, or equivalent. Electrical connection can also be made to the base and emitter pins by soldering directly to the pins. Soldering of connections to the pins may be made close to the pin seals provided care is taken to conduct excessive heat away from the pin seal, otherwise the heat of the soldering operation will crack the glass seals of the pins and damage the transistor.

In application where the chassis is connected to the negative terminal of the voltage supply, it will be necessary to use an anodized-aluminum insulator having high thermal conductivity, or a 0.002" mica insulator between the mounting flange and the chassis. An aluminum washer should be drilled or punched to provide the two mounting holes, and the clearance holes for the emitter and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolt and the chassis, it is important that an insulating washer be used between the bolt and the chassis (See *Suggested Mounting Arrangement*).

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

To prevent damage to the transistor by thermal runaway, an external resistance may be placed in the emitter or collector circuit. The minimum value of this resistance may be obtained from the following equation:

$$R_{\min} = \frac{E^2}{4(P_o + \frac{25}{K})}$$

where:

E = DC collector supply voltage (Volts)

P_o = Collector-to-emitter voltage x collector current at desired operating point (Watts)

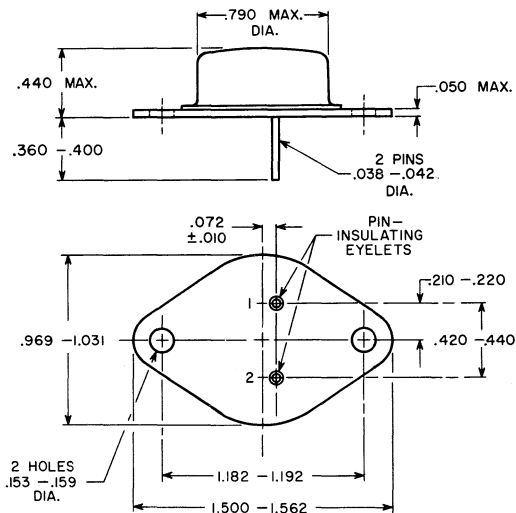
K = Thermal resistance — transistor and heat sink ($^{\circ}\text{C}/\text{Watt}$)

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Electronic Components and Devices

Harrison, N. J.



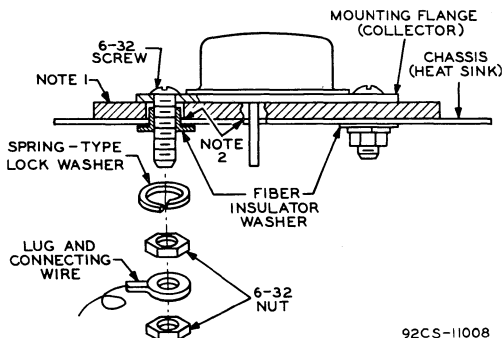
DIMENSIONAL OUTLINE



92CS-11000R2

DIMENSIONS IN INCHES

SUGGESTED MOUNTING ARRANGEMENT



92CS-11008

Note 1: 0.002" mica insulator or anodized aluminum insulator (drilled or punched with burrs removed).

Note 2: Remove burrs from chassis holes.

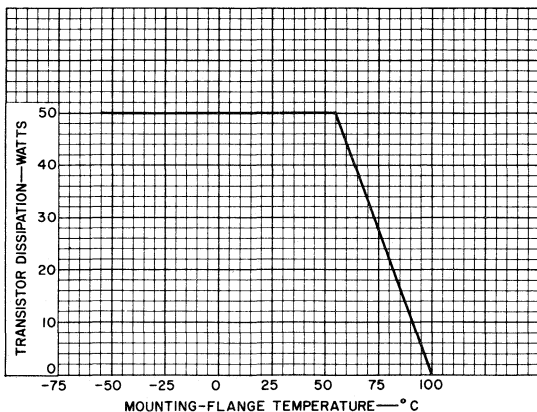


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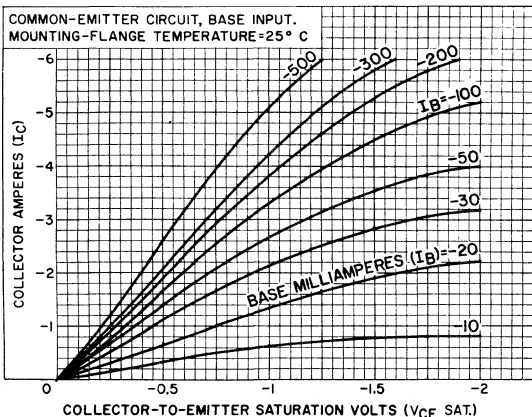
DATA 2
2-66

RATING CHART



92CS-1099IRI

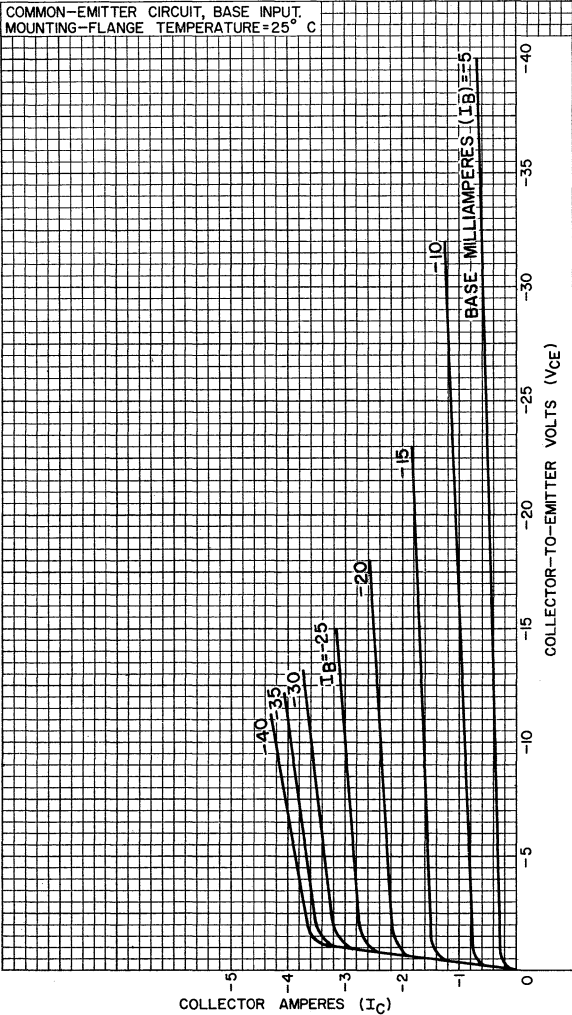
TYPICAL COLLECTOR-TO-EMITTER SATURATION-VOLTAGE CHARACTERISTICS



92CS-10997



TYPICAL COLLECTOR CHARACTERISTICS



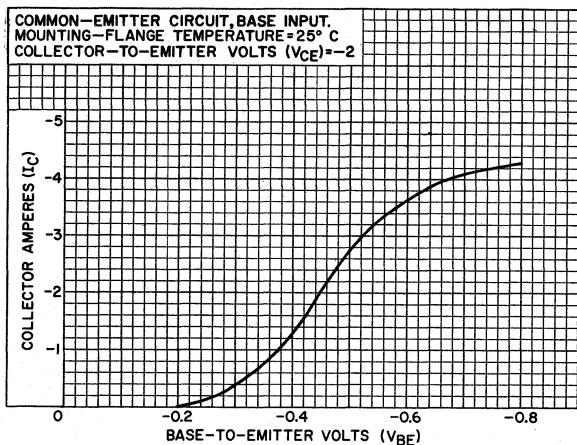
92CM-10999RI



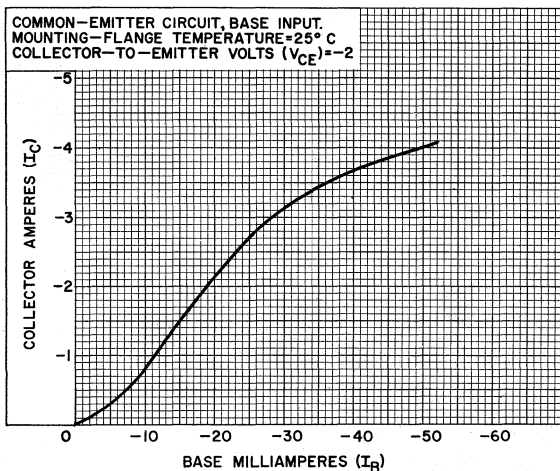
RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

DATA 3
6-61

TYPICAL CHARACTERISTICS



92CS-10995



92CS-10993

Power Transistor

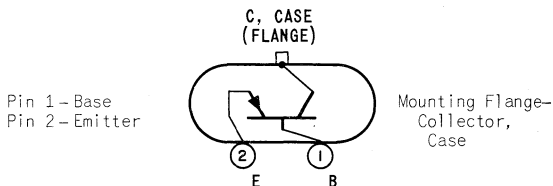
GERMANIUM P-N-P DRIFT-FIELD TYPE

*For Use in Power-Switching Circuits, DC-to-DC Converters,
Inverters, Ultrasonic Oscillators and Large-Signal
Wide-Band Linear Amplifiers*

MECHANICAL

Dimensions See *Dimensional Outline* under Type 2N1905

TERMINAL DIAGRAM (Bottom View)



ABSOLUTE-MAXIMUM RATINGS

Collector-to-Base Voltage.	V_{CB0}	-130	V
Collector-to-Emitter Voltage.	V_{CE0}	-60	V
Emitter-to-Base Voltage.	V_{EB0}	-1.5	V
Collector Current.	I_C	-6	A
Emitter Current.	I_E	6	A
Base Current.	I_B	-1	A

Transistor Dissipation

At mounting-flange temperatures:

From -55 to 55°C	P_T	30	W
Above 55°C	Derate linearly to 0 W at 100°C		

Temperature Range

Operating (Junction)	$T(opr)$	-55 to 100	°C
Storage.	$T(stg)$	-55 to 100	°C
Pin-Soldering Temperature ^a		255	°C

For 10 s max

← Indicates a change.



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DATA 1
2-66

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode voltage and electrode-current values for given test conditions are dc at mounting-flange temperature^b = 25°C

Collector-to-Emitter Sustaining Voltage			
$I_C = -100 \text{ mA}, I_B = 0$	$V_{CE0}(\text{sus})$	-60 min	V
Collector-to-Emitter Saturation Voltage			
$I_C = -5A, I_B = 0.25A$	$V_{CE}(\text{sat})$	-0.5 max	V
Base-to-Emitter Voltage			
$V_{CE} = -2V, I_C = -1A$	V_{BE}	-0.5 max	V
Collector-Cutoff Current			
$V_{CB} = -130V, V_{BE} (\text{floating}) = 1V$	I_{CBO}	-10 max	mA
Emitter-Cutoff Current			
$V_{EB} = 1.5V, I_C = 0$	I_{EBO}	-2.5 max	mA
Static Forward-Current Transfer Ratio			
$V_{CE} = -2V, I_C = -5A$	h_{FE}	75 min	
$V_{CE} = -2V, I_C = -1A$	h_{FE}	75 to 250	
Small-Signal Forward-Current Transfer Ratio			
$f = 1 \text{ kc/s}, V_{CE} = -5V, I_C = -0.5A$	h_{fe}	50 to 300	
$f = 1 \text{ Mc/s}, V_{CE} = -5V, I_C = -0.5A$	h_{fe}	3 min	

TYPICAL OPERATION

In accompanying typical "on-off" power-switching circuit at mounting-flange temperature = 25°C

DC Collector-Supply Voltage.	V_{CC}	5	12.5	12.5	V
On DC Collector Current.	I_C	-1	-2.5	-5	A
Turn-On DC Base Current.	I_{B1}	-	-0.25	-0.25	A
Turn-Off DC Base Current.	I_{B2}	-	0.25	0.25	A
Pulse-Generator Open-Circuit Voltage .		2	-	-	V
Base-Bias Resistor		75	5	5	Ω
"Speed-Up" Capacitor		0.1	-	-	μF
Load Resistor.	R_L	5	5	2.5	Ω
Generator Impedance.	R_G	5	5	5	Ω
Switching Time:					
Delay time	t_d	0.1	0.1	0.1	μs
Rise time.	t_r	0.1	0.4	0.9	μs
Storage time	t_s	1	7	7	μs
Fall time.	t_f	0.6	1	2	μs

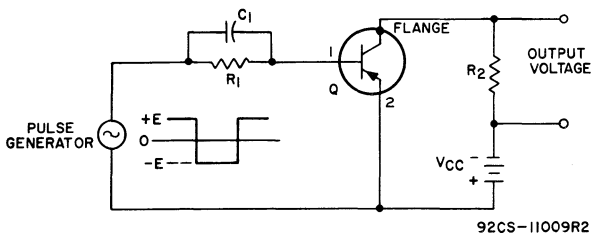
^a Measured at center of seating surface.

^b Measured along pin at distances $1/16 \pm 1/32$ inch from seating surface.

→ Indicates a change.

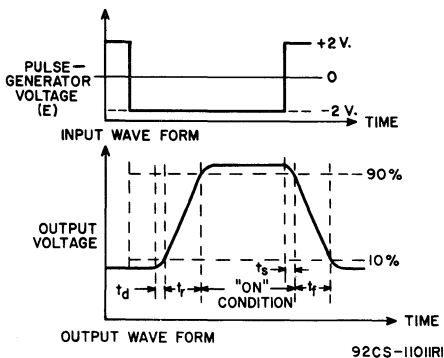


TYPICAL "ON-OFF" POWER SWITCHING CIRCUIT



Q: Transistor type 2N1906

ASSOCIATED WAVE FORMS



OPERATING CONSIDERATIONS,
 DIMENSIONAL OUTLINE,
 and
 SUGGESTED MOUNTING ARRANGEMENT
 shown under type 2N1905 also apply to the 2N1906

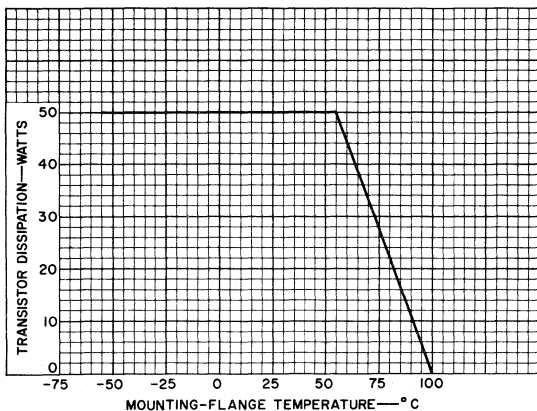


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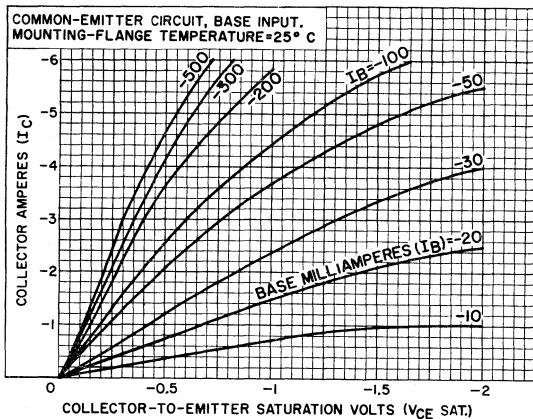
DATA 2
 2-66

Rating Chart



92CS-10991RI

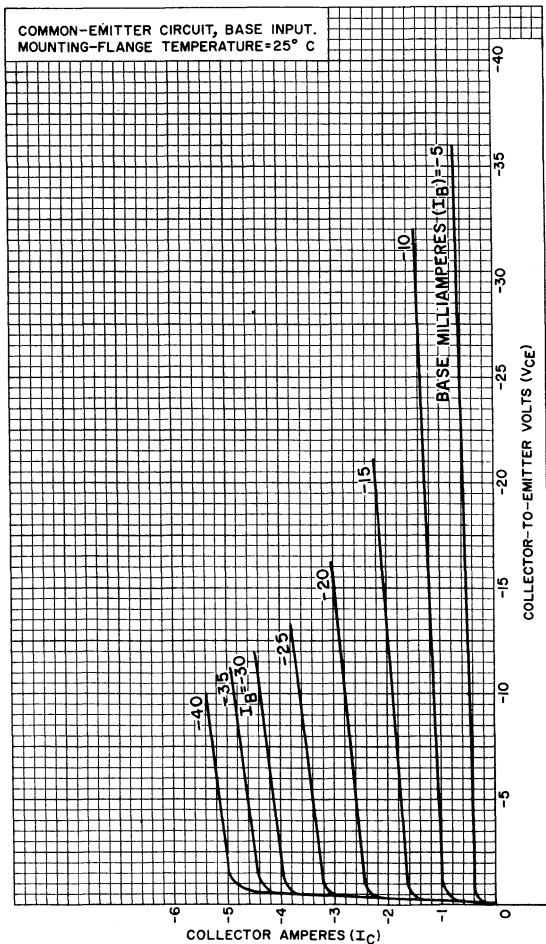
Typical Collector-to-Emitter Saturation-Voltage Characteristics



92CS-10998



Typical Collector Characteristics



92CM-10996R1

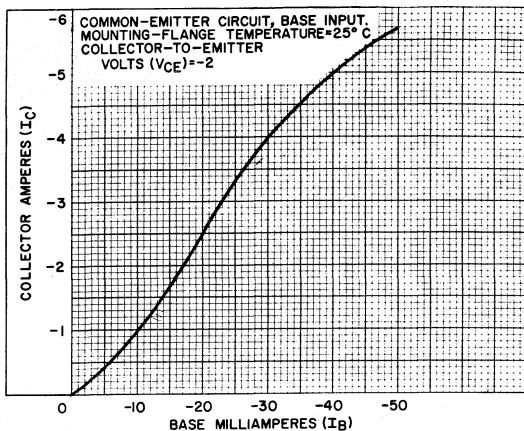
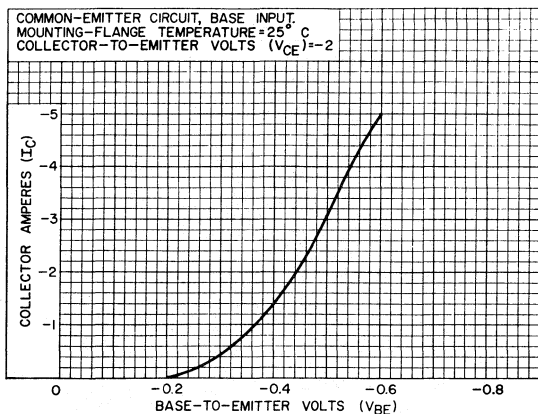


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Electronic Components and Devices

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DATA 3
2-66

Typical Characteristics



Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE

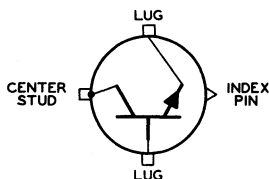
For Power Switching and Amplifier Applications in Industrial and Military Equipment

GENERAL DATA

Mechanical:

Dimensions. See Outline TO-36 in General Section

Terminal Diagram: BOTTOM VIEW



INDUSTRIAL SERVICE

Such as dc-to-dc converter, inverter, chopper, relay-control, oscillator, regulator, pulse-amplifier circuits, and as a class A and class B push-pull amplifier for af and servo applications

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CBO}	100 max.	volts
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open.	V_{CEO}	50 max.	volts
EMITTER-TO-BASE VOLTAGE:			
With collector open	V_{EBO}	10 max.	volts
COLLECTOR CURRENT	I_C	10 max.	amp
EMITTER CURRENT	I_E	-13 max.	amp
BASE CURRENT.	I_B	6 max.	amp
TRANSISTOR DISSIPATION:		P_T	
At case temperatures: ^a			
From -65° to 25° C.		150 max.	watts
Above 25° C	Derate linearly 0.855 watt/°C		
TEMPERATURE RANGE:			
Operating (Case) ^a	T_{OPR}	-65 to 200	°C
Storage	T_{STG}	-65 to 200	°C
LUG TEMPERATURE: ^b			
For 10 seconds maximum.	T_L	235 max.	°C

Typical Operation:

In accompanying pulse-response test circuit at case temperature^a = 25° C

DC Collector Supply Voltage . . .	V_{CC}	24	volts
DC Base Supply Voltage	V_{BB}	-6	volts

← Indicates a change.



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DATA 1
3-63

"On" DC Collector Current	I_C	10	amp
"Turn-On" Base Current	I_{B1}	2	amp
Base Resistance	R_{B1}	10	ohms
Base Resistance	R_{B2}	10	ohms
Collector Resistance	R_C	2	ohms
Switching Time:			
"Turn-on" time [Delay time (t_d) + rise time (t_r)]	t_{on}	4	μsec
"Turn-off" time [Storage time (t_s) + fall time (t_f)]	t_{off}	7	μsec

^a Measured at intersection of seating plane with mounting stud.

^b Measured $1/16" \pm 1/32"$ along lug down from seating plane.

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, case temperature^a = 25°C

Min. Typical Max.

DC Collector-to-Emitter Voltage:				
With emitter-to-base reverse bias dc volts = -1.5, dc collector ma. = 2				
	V_{CEX}	-	-	100 volts
With base open (Sustaining voltage), dc collector ma. = 200				
	$V_{CEO(sus)}^c$	50	-	- volts
DC Base-to-Emitter Voltage for dc collector-to-emitter volts = 4, dc collector amperes = 5				
	V_{BE}	-	-	2.2 volts
→ DC Collector-to-Emitter Saturation Voltage for dc collector amperes = 5, dc base amperes = 0.5				
	$V_{CE(sat)}$	-	-	1.25 volts
→ DC Collector-Cutoff Current:				
With dc collector-to-emitter volts = 40, base current = 0				
	I_{CEO}	-	-	0.2 ma
With dc collector-to-emitter volts = 100, base-to-emitter reverse bias dc volts = -1.5				
	I_{CEX}	-	-	2 ma
With dc collector-to-emitter volts = 30, base-to-emitter reverse bias dc volts = -1.5, case temperature ^a = 150°C				
	I_{CEX}	-	-	2 ma

→ Indicates a change.



Min. Typical Max.

DC Emitter-Cutoff Current for dc emitter-to-base volts = 10, collector current = 0	I_{EBO}	-	-	0.05	ma	←
DC Forward-Current Transfer Ratio for dc collector-to- emitter volts = 4, dc collector amperes =	h_{FE}					
5		15	-	50		
9		8	-	-		
Small-Signal Short-Cir- cuit Forward-Current Transfer Ratio for dc collector-to-emitter volts = 4, dc collector amperes = 1, frequency (kc) = 1	h_{fe}	12	-	60		←
Small-Signal Short-Cir- cuit Forward-Current Transfer Ratio Cutoff Frequency for dc col- lector-to-emitter volts = 4, dc collector amperes = 5	f_{hfe}	12	-	-	kc	
Collector-to-Emitter Saturation Resistance for dc collector amperes = 5, dc base amperes = 0.5	R_S	-	-	0.25	ohm	
Output Capacitance for dc collector-to-base volts = 40, dc col- lector μ a = 50, fre- quency (Mc) = 1	C_{ob}	-	-	400	pf	
Thermal Time Constant . .	τ_I	-	30	-	msec	
Thermal Resistance: Junction-to-case	θ_{JC}	-	-	1.17	°C/watt	

^a Measured at intersection of seating plane with mounting stud.

^c The Collector-to-Emitter Sustaining Voltage ($V_{CE0(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connection can be made to the base and emitter lugs by means of clips or by soldering directly to the lugs.

← Indicates a change.



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DATA 2
3-63

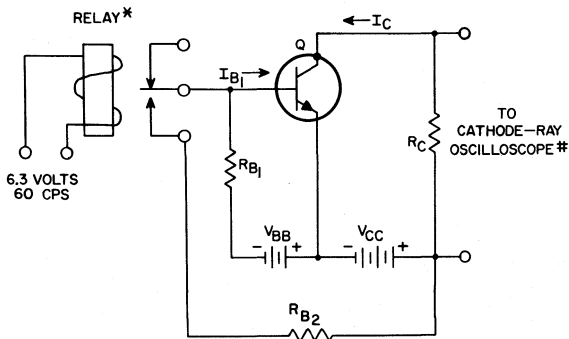
2N2015

When soldering connections are made to the lugs, care should be taken to conduct excessive heat away from the lug seals, otherwise the heat of the soldering operation will crack the glass seals of the lugs and damage the transistor.

This transistor is provided with a single-ended stud for mounting to a heat sink and for electrical connection to the collector. (See accompanying *Suggested Mounting Arrangement*). Electrical connection to the base and to the emitter is made to their respective lugs.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

PULSE-RESPONSE TEST CIRCUIT



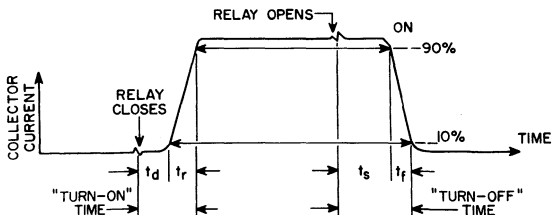
*C.P. CLARE TYPE HGP-1028
OR EQUIVALENT

#TEKTRONIX TYPE 545
OR EQUIVALENT

92CS-11129RI

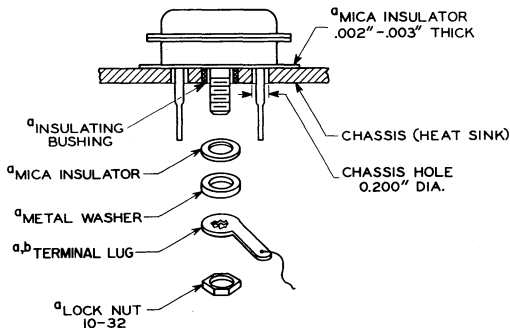
Q: Transistor type 2N2015

ASSOCIATED WAVE FORM



92CS-III26RI

SUGGESTED MOUNTING ARRANGEMENT



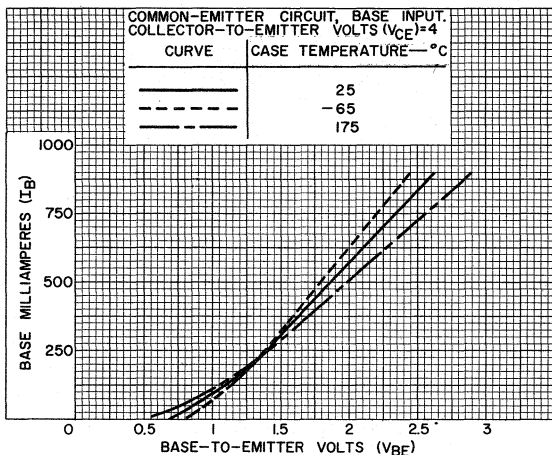
92CS-III33

^a SUPPLIED WITH EACH TRANSISTOR.

^b SHAKEPROOF DIVISION, ILLINOIS TOOL WORKS,
CATALOG No. 2102-6.

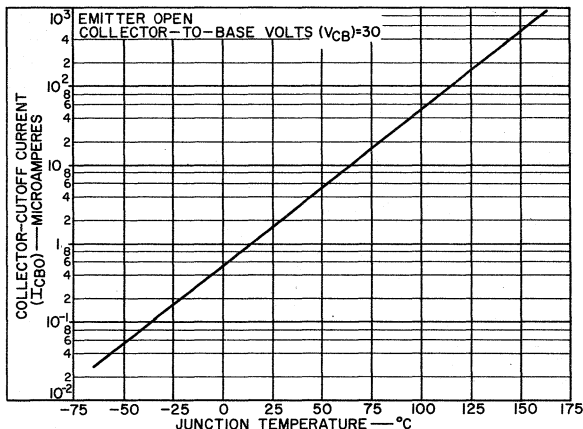


TYPICAL BASE CHARACTERISTICS



92CS-11093RI

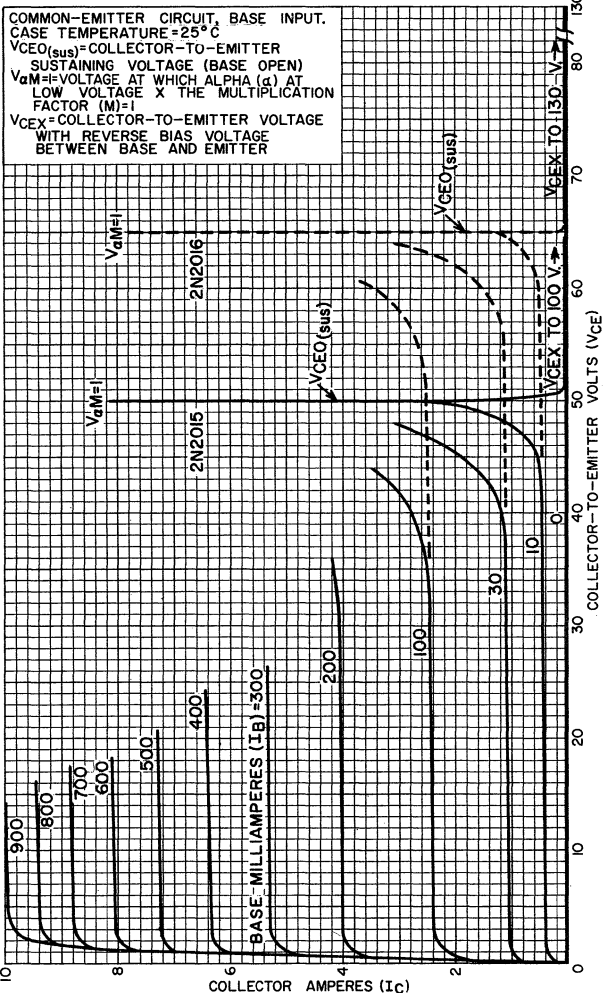
TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTIC



92CS-11094



TYPICAL COLLECTOR CHARACTERISTICS



92CM-11092RI

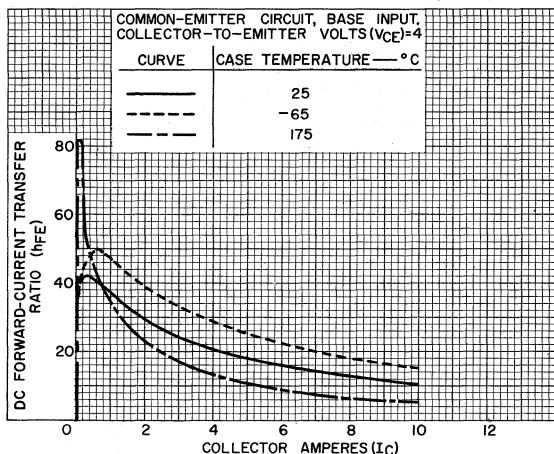


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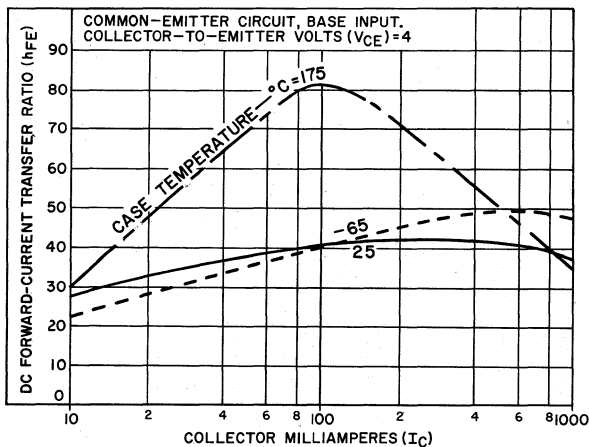
Somerville, N. J.

DATA 4
3-63

TYPICAL DC FORWARD-CURRENT-TRANSFER-RATIO CHARACTERISTICS



92CS-11090RI



92CS-11095RI



Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE

For Power Switching and Amplifier Applications in Industrial and Military Equipment

The 2N2016 is the same as the 2N2015 except for the following items:

INDUSTRIAL SERVICE

Such as dc-to-dc converter, inverter, chopper, relay-control, oscillator, regulator, pulse-amplifier circuits, and as a class A and class B push-pull amplifier for af and servo applications

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CBO} 130 max. volts

COLLECTOR-TO-EMITTER

VOLTAGE:

With base open V_{CEO} 65 max. volts

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, case temperature^a = 25° C

Min. Typical Max.

DC Collector-to-Emitter

Voltage:

With emitter-to-base
reverse bias dc volts
= -1.5, dc collector

ma. = 2. V_{CEX} - - 130 volts

With base open (Sustain-
ing voltage), dc col-
lector ma. = 200 . . . $V_{CEO(sus)}^c$

- - 65 volts

DC Collector-Cutoff

Current:

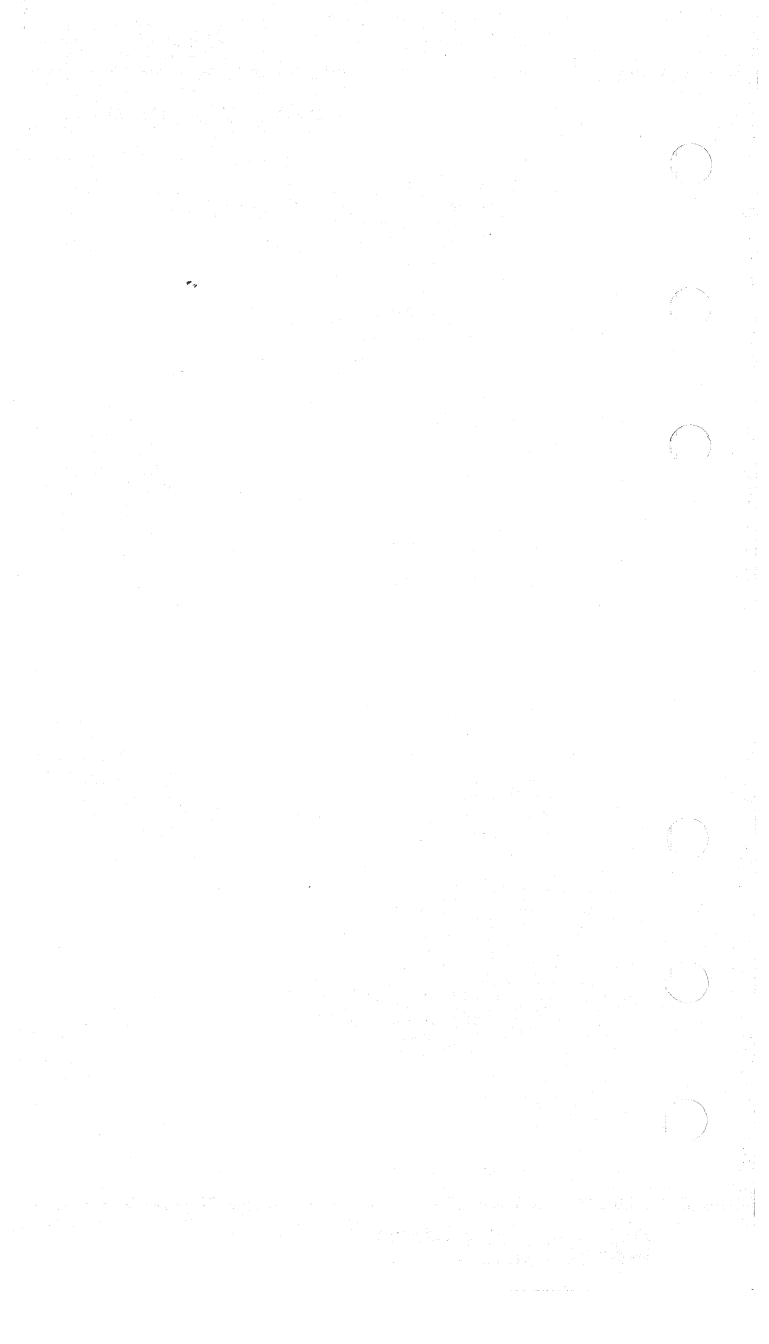
With dc collector-to-
emitter volts = 130,
base-to-emitter reverse
bias dc volts = -1.5 .

I_{CEX} - - 2 ma

^a Measured at intersection of seating plane with mounting stud.

^c The Collector-to-Emitter Sustaining Voltage ($V_{CEO(sus)}$) with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{\alpha M} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).





Transistor

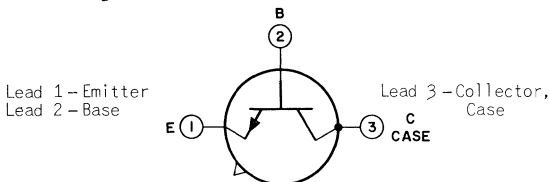
SILICON N-P-N TRIPLE-DIFFUSED PLANAR TYPE

*For Small-Signal and Medium Power Applications
in Industrial and Military Equipment*

Dimensions. See Outline TO-5 in General Section

Terminal Diagram:

BOTTOM VIEW



INDUSTRIAL SERVICE

MAXIMUM RATINGS, Absolute-Maximum Values

Collector-to-Base Voltage	V_{CB0}	120	V
Collector-to-Emitter Voltage			
$R_{BE} \leq 10 \Omega$	V_{CER}	80	V
Base open	V_{CEO}	65	V
Emitter-to-Base Voltage	V_{EB0}	7	V
Collector Current	I_C	1	A
Transistor Dissipation			
At case temperatures: ^a			
From -65° to 25° C	P_T	5	W
Above 25° C	Derate linearly 0.029 W/ $^\circ$ C		
At free-air temperatures:			
From -65° to 25° C	P_T	1	W
Above 25° C	Derate linearly 0.006 W/ $^\circ$ C		
Temperature Range			
Operating (Junction)	T_{opr}	-65 to 200	$^\circ$ C
Storage	T_{stg}	-65 to 300	$^\circ$ C
Lead-Soldering Temperature ^b	T_L	300	$^\circ$ C

ELECTRICAL CHARACTERISTICS

*Unless otherwise specified, electrode-voltage
and electrode-current values for given test
conditions are dc at case temperature = 25° C*

		Min	Max	
Collector-to-Base Breakdown Voltage.	BV_{CB0}	120	-	V
$I_C = 0.1$ mA, $I_E = 0$				



2N2102

		Min	Max	
Emitter-to-Base				
Breakdown Voltage.	BV_{EB0}	7	-	V
$I_E = 0.1 \text{ mA}, I_C = 0$				
Collector-to-Emitter				
Sustaining Voltage				
I_C (pulsed) = 100 mA, ^c				
$R_{BE} = 10 \Omega$	$V_{CER(sus)}$	80	-	V
$I_B = 0$	$V_{CEO(sus)}$	65	-	V
Base-to-Emitter				
Saturation Voltage	$V_{BE(sat)}$	-	1.1	V
I_C (pulsed) = 150 mA ^c				
I_B (pulsed) = 15 mA ^c				
Collector-to-Emitter				
Saturation Voltage	$V_{CE(sat)}$	-	0.5	V
I_C (pulsed) = 150 mA ^c				
I_B (pulsed) = 15 mA ^c				
Collector-Cutoff Current				
$V_{CB} = 60 \text{ V}, I_E = 0,$				
$T_C = 25^\circ \text{ C}$	I_{CB0}	-	0.002	μA
$T_C = 150^\circ \text{ C}$	I_{CB0}	-	2	μA
→ Emitter-Cutoff Current	I_{EB0}	-	0.005	μA
$V_{EB} = 5 \text{ V}, I_C = 0$				
DC Forward-Current				
Transfer Ratio				
$V_{CE} = 10 \text{ V},$				
$I_C = 0.01 \text{ mA}$	h_{FE}	10	-	
$I_C = 0.1 \text{ mA}$	h_{FE}	20	-	
I_C (pulsed) = 10 mA ^c	h_{FE}	35	-	
I_C (pulsed) = 150 mA ^c	h_{FE}	40	120	
I_C (pulsed) = 500 mA ^c	h_{FE}	25	-	
I_C (pulsed) = 1000 mA ^c	h_{FE}	10	-	
I_C (pulsed) = 10 mA, ^c				
$T_C = -55^\circ \text{ C}$	h_{FE}	20	-	
→ Small-Signal Forward				
Current Transfer Ratio				
$f = 1 \text{ kc/s}, V_{CE} = 5 \text{ V},$				
$I_C = 1 \text{ mA}$	h_{fe}	40	125	
$f = 1 \text{ kc/s}, V_{CE} = 10 \text{ V},$				
$I_C = 5 \text{ mA}$	h_{fe}	45	190	
$f = 20 \text{ Mc/s}, V_{CE} = 10 \text{ V},$				
$I_C = 50 \text{ mA}$	h_{fe}	6	-	
Small-Signal Reverse-Voltage				
(Feedback) Transfer Ratio				
$f = 1 \text{ kc/s},$				
$V_{CB} = 5 \text{ V}, I_C = 1 \text{ mA}$	h_{rb}	-	0.0003	
$V_{CB} = 10 \text{ V}, I_C = 5 \text{ mA}$	h_{rb}	-	0.0003	
Input Impedance				
$f = 1 \text{ kc/s},$				
$V_{CB} = 5 \text{ V}, I_C = 1 \text{ mA}$	h_{ib}	24	34 Ω	
$V_{CB} = 10 \text{ V}, I_C = 5 \text{ mA}$	h_{ib}	4	8 Ω	

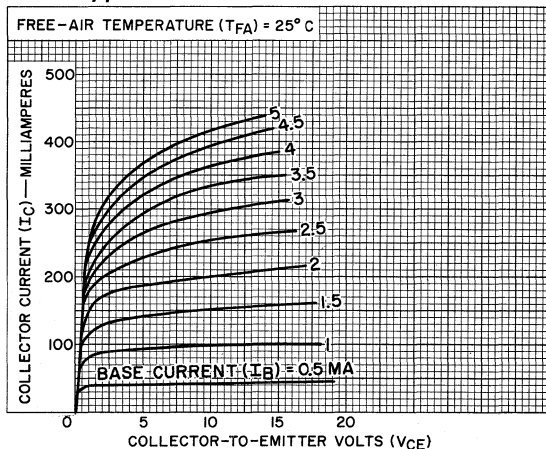
→ Indicates a change.



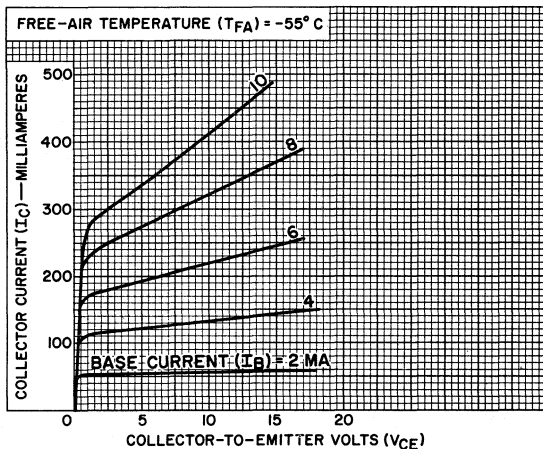
		Min	Max
Output Conductance			
$f = 1 \text{ kc/s,}$			
VCB = 5 V, $I_C = 1 \text{ mA}$	h_{ob}	0.1	0.5 μmho
VCB = 10 V, $I_C = 5 \text{ mA}$	h_{ob}	0.1	1 μmho
Input Capacitance	C_{ib}	-	80 pF
$V_{EB} = 0.5 \text{ V, } I_C = 0$			
Output Capacitance.	C_{ob}	-	15 pF
VCB = 10 V, $I_E = 0$			
Noise Figure.	NF	-	6 db
Circuit bandwidth = 1 c/s,			
$f = 1 \text{ kc/s}$ (reference signal),			
$R_G = 510 \Omega$, $I_C = 0.3 \text{ mA}$,			
$V_{CE} = 10 \text{ V}$			
Thermal Resistance			
Junction-to-case.	θ_{JC}	-	35 $^{\circ}\text{C/W}$
Junction-to-free air.	θ_{JFA}	-	175 $^{\circ}\text{C/W}$
^a Measured at center of seating plane.			
^b Measured $1/16" \pm 1/32"$ along lead from seating plane.			
^c Pulse duration = 300 μs ; duty factor = 0.018.			



Typical Collector Characteristics



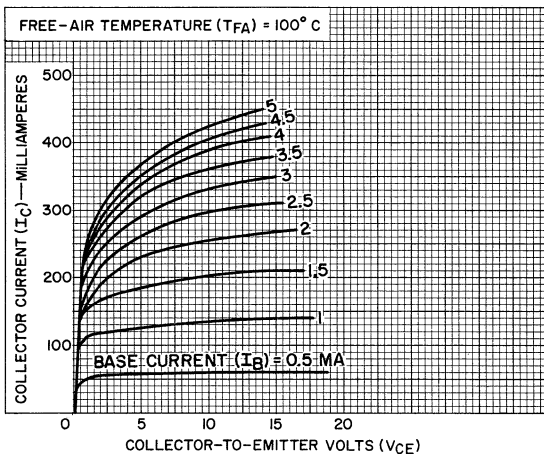
92CS-12667



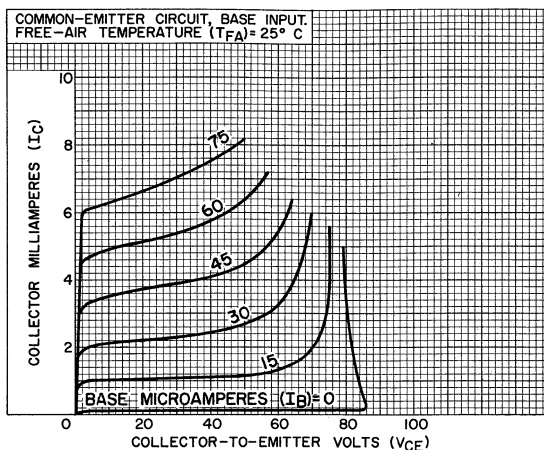
92CS-12668



Typical Collector Characteristics



92CS-12665



92CS-11175

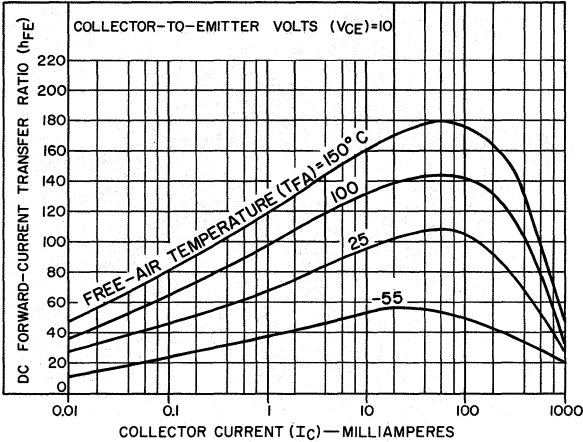


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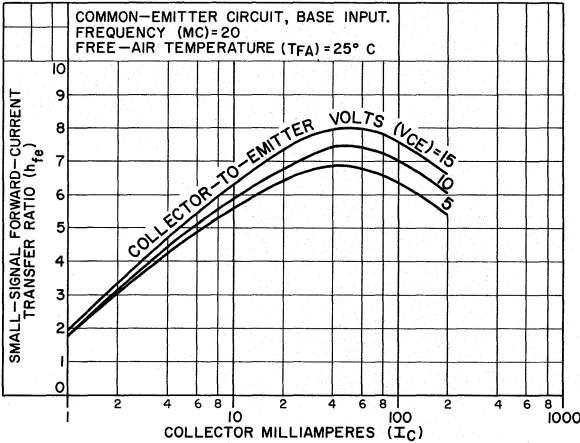
DATA 3
5-65

Typical DC Forward-Current
Transfer-Ratio Characteristics



92CS-11181R2

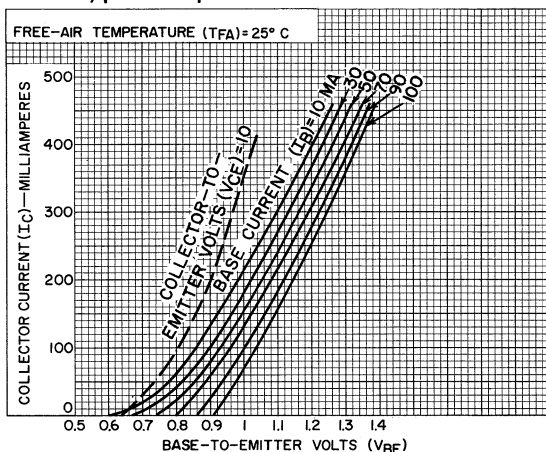
Typical Small-Signal Forward-Current
Transfer-Ratio Characteristics



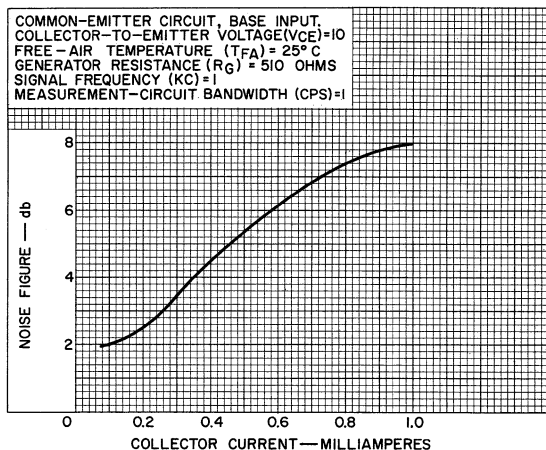
92CS-11171



Typical Operation Characteristics



92CS-11185RI



92CS-12220

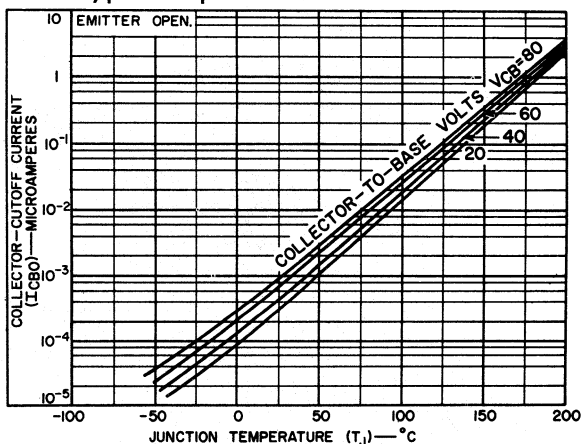


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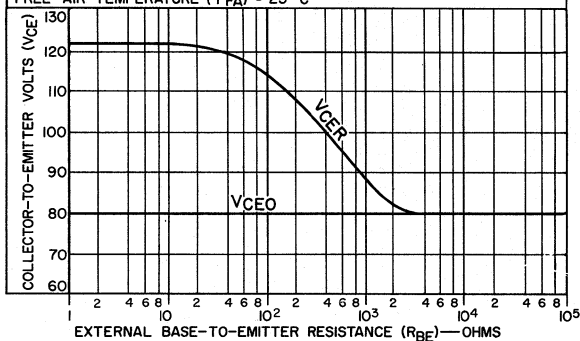
DATA 4
5-65

Typical Operation Characteristics



92CS-13160

V_{CE} = COLLECTOR-TO-EMITTER VOLTAGE WITH EXTERNAL RESISTANCE BETWEEN BASE AND EMITTER
 V_{CEO} = COLLECTOR-TO-EMITTER VOLTAGE WITH BASE OPEN
 COMMON-EMITTER CIRCUIT, BASE INPUT.
 COLLECTOR MILLIAMPERES (I_C) = 100 (PULSED)
 FREE-AIR TEMPERATURE (T_{FA}) = 25° C



92CS-11193R2



Power Transistor

GERMANIUM P-N-P, DIFFUSED COLLEC-
TOR, GRADED-BASE, DRIFT-FIELD TYPE

For High-Fidelity Audio-Frequency-Amplifier Applications

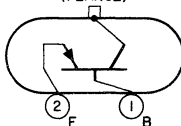
Mechanical:

Dimensions. See Outline TO-3 in General Section
Pin Length. 0.440" — 0.480"
Maximum Mounting-flange Thickness 0.050"

Terminal Diagram

BOTTOM VIEW

C, CASE
(FLANGE)



Pin 1 — Base
Pin 2 — Emitter

MOUNTING FLANGE—
Collector,
Case

AUDIO-FREQUENCY POWER AMPLIFIER SERVICE

Maximum and Minimum Ratings, *Absolute-Maximum Values:*

Collector-to-Base Voltage.	V_{CBO}	-75 max.	volts
With emitter open			
Collector-to-Emitter Voltage	V_{CEO}	-50 max.	volts
With base open			
Emitter-to-Base Voltage.	V_{EBO}	-1.5 max. ^a	volts
With collector open			
Collector Current.	I_C	-5 max.	amp
Emitter Current.	I_E	5 max.	amp
Base Current	I_B	-1 max.	amp

Transistor Dissipation

Average:

At mounting-flange temperatures^b

From -65° to 81° C P_T 12.5 max. watts

Above 81° C Derate linearly 0.66 watt/°C

Peak:

Determined by operating

conditions See Collector Characteristics Curves

Temperature

Operating range (Junction)	T_{opr}	-65 to 100	°C
Storage range.	T_{stg}	-65 to 100	°C
Pins ^c (During soldering):			
For 10 seconds maximum	T_p	255 max.	°C

← Indicates a change.



ELECTRICAL CHARACTERISTICS

Mounting-flange temperature^b = 25° C, unless otherwise specified

Min. Typ. Max.

DC Collector-to-Base Breakdown Voltage.	BV _{CBO}	-75	-	-	volts
$I_C = -10 \text{ ma.}, I_E = 0$					
DC Collector-to-Emitter Breakdown Voltage.	BV _{CEO}	-50	-	-	volts
$I_C = -100 \text{ ma.}, I_B = 0$					
DC Base-to-Emitter Voltage.	V _{BE}	-	-0.24	-	volt
$V_{CE} = -10 \text{ volts}, I_C = -50 \text{ ma.}$					
DC Collector-Cutoff Current	I _{CBO}	-	-	-1	ma
$V_{CB} = -40 \text{ volts}, I_E = 0$					
DC Emitter-Cutoff Current	I _{EBO}	-	-	-2.5	ma
$V_{EB} = -1.5 \text{ volts}, I_C = 0$					
DC Collector-Cutoff Saturation Current.	I _{CBO(sat)}	-	-	-70	μa
$V_{CB} = -0.5 \text{ volt}, I_E = 0$					
DC Forward-Current Transfer Ratio.	h _{FE}	100	150	-	
$V_{CE} = -1 \text{ volt}, I_C = -1 \text{ ampere}$					
Gain-Bandwidth Product.	f _T	-	4	-	Mc
$V_{CE} = -5 \text{ volts}, I_C = -0.5 \text{ ampere}$					
Thermal Resistance.	θ _{JMF}	-	-	1.5	°C/watt
Junction-to-mounting-flange					

Typical Operation:

In accompanying "single-ended push-pull" class B AF-amplifier circuit at mounting-flange temperature of 25° C

Unless otherwise specified, values are for 2 transistors

DC Collector Supply Voltage (V _{CC}) ^d	-22	volts
Zero-Signal Base-Bias Voltage	-0.24	volt
Zero-Signal DC Collector Current.	-0.05	amp
Maximum-Signal DC Collector Current	-1.1	amp
Peak Collector Current.	-3.5	amp
→ Input Impedance of Stage (Per base)	75	ohms
Load Impedance (Speaker voice-coil)	4	ohms
Maximum Collector Dissipation (Per transistor under worst-case conditions)	12.5	watts
Music Power Output ^e	45	watts
→ Power Gain.	33	db
Total Harmonic Distortion	5	%
Maximum-Signal Power Output	25	watts

→ Indicates a change.



- a This rating may be exceeded provided the combined dissipation in the emitter and the collector does not exceed the maximum dissipation rating for the device, and provided the driver stage (transformer coupled) is capable of providing the emitter-to-base current drawn by the transistors under the emitter-to-base voltage conditions (reverse-bias) shown.
- b Measured at center of seating plane.
- c Measured along pin at distances not less than 1/16" from seating plane.
- d The data shown are for a dc collector supply having 10 per cent regulation.
- e Determined according to EIA Standard RS 234, Section 2.1.2.1.

OPERATING CONSIDERATIONS

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

This transistor can be installed in a commercially available socket. Electrical connection can also be made to the base and emitter pins by soldering directly to the pins. Soldering of connections to the pins may be made close to the pin seals provided care is taken to conduct excessive heat away from the pin seal, otherwise the heat of the soldering operation will crack the seals of the pins and damage the transistor.

Under no circumstances should the mounting flange be soldered to the heat sink because the heat of the soldering operation will permanently damage the transistor.

It is important that the mounting flange which serves as the collector terminal be securely fastened to a heat sink.

In applications where the chassis is connected to the positive terminal of the voltage supply, it will be necessary to use an anodized-aluminum insulator having high thermal conductivity, or a 0.002" mica insulator between the mounting flange and the chassis. The insulator should extend beyond the mounting-flange. An aluminum washer should be drilled or punched to provide the two mounting holes, and the clearance holes for the emitter and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolt and the chassis, it is important that a fiber washer be used between the bolt and the chassis. See *Suggested Mounting Arrangement*.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard, when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

To assure that the transistor operates at all times within the regions shown in the accompanying collector characteristics curve, the circuit designer should take into account the possible effects of the following factors:

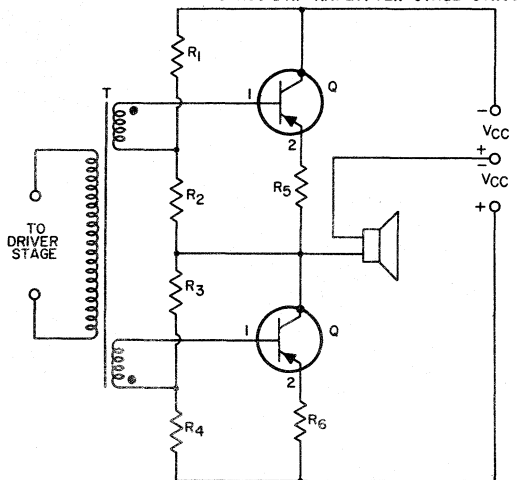


2N2147

- (1) phase shift due to circuit capacitances and/or speaker resonance
- (2) parasitic oscillations, such as "ringing" caused by excessive or improperly neutralized feedback
- (3) high line voltage
- (4) variations in speaker impedance
- (5) overdriving of transistors
- (6) non-sinusoidal signal wave forms

Any of these factors, or combination of these factors, can change the character and value of the transistor load sufficiently to cause operation outside the region of reliability shown in the accompanying collector characteristics curve.

"SINGLE-ENDED PUSH-PULL" CLASS B AF AMPLIFIER-STAGE CIRCUIT



92CS-11332R2

Q: Transistor Type 2N2147

R_1, R_3 : 330 ohms $\pm 10\%$, 2 watts

R_2, R_4 : 3.9 ohms $\pm 10\%$, 0.5 watt

R_5, R_6 : 0.27 ohm $\pm 10\%$, 0.5 watt

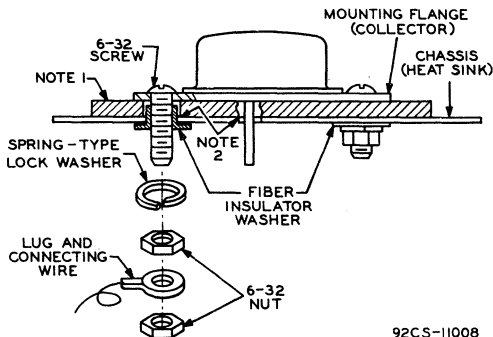
Speaker: Voice-Coil Impedance. . 4 ohms

T: Driver Transformer. Primary-winding impedance, current-carrying capacity, and dc resistance determined by large-signal characteristics of driver stage; secondary windings bifilarwound, impedance of each winding = 100 ohms.

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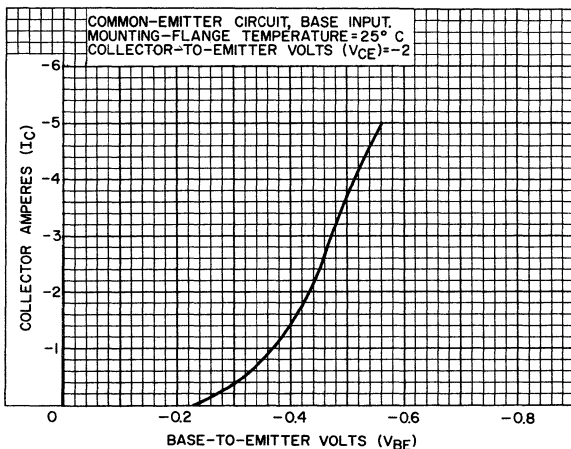
SUGGESTED MOUNTING ARRANGEMENT



NOTE 1: 0.002" Mica Insulator or Anodized Aluminum Insulator (Drilled or Punched with Burrs Removed).

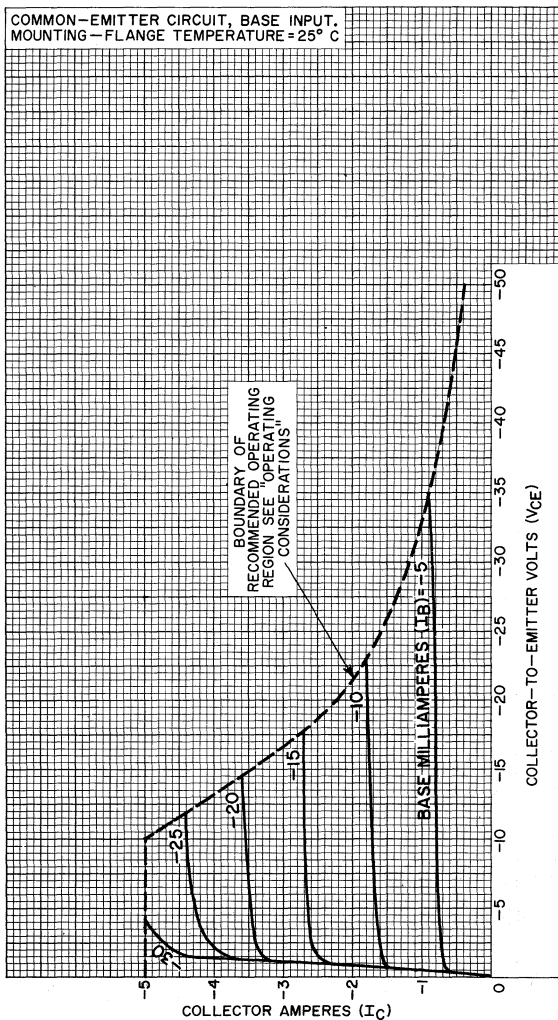
NOTE 2: Remove Burrs from Chassis Holes.

TYPICAL TRANSFER CHARACTERISTIC



TYPICAL COLLECTOR CHARACTERISTICS

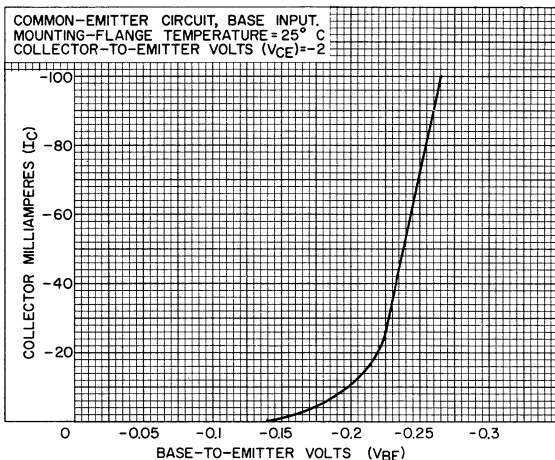
COMMON-EMITTER CIRCUIT, BASE INPUT,
MOUNTING-FLANGE TEMPERATURE = 25° C



92CM-11331R2

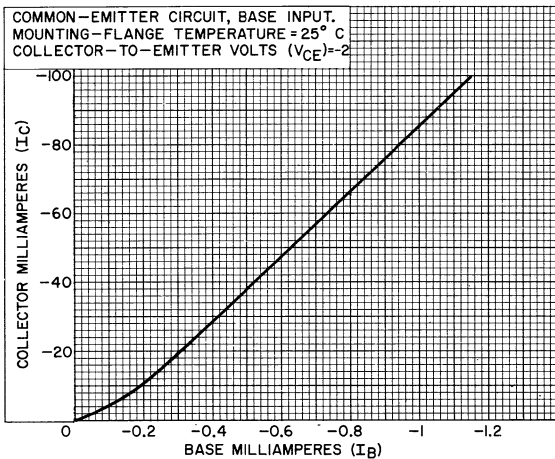


TYPICAL TRANSFER CHARACTERISTIC



92CS-11326

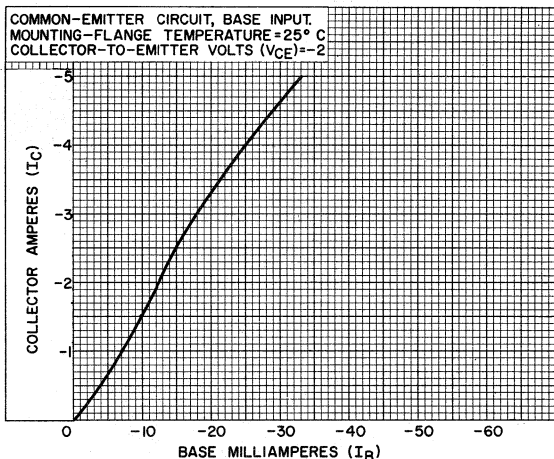
TYPICAL CURRENT-TRANSFER CHARACTERISTIC



92CS-11834RI

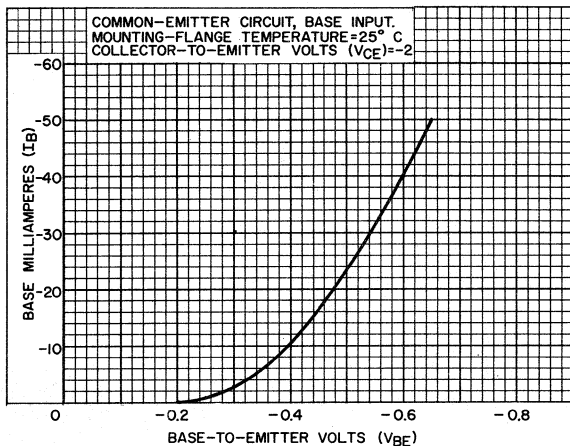


TYPICAL CURRENT-TRANSFER CHARACTERISTIC



92CS-11325RI

TYPICAL INPUT CHARACTERISTIC



92CS-11327RI

Power Transistor

GERMANIUM P-N-P, DIFFUSED COLLEC-
TOR, GRADED-BASE, DRIFT-FIELD TYPE

For High-Fidelity Audio-Frequency-Amplifier Applications

Mechanical:

Dimensions. See *Outline TO-3* in General Section

Pin Length. 0.440" - 0.480"

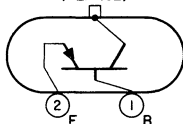
Maximum Mounting-flange Thickness. 0.050"

Terminal Diagram

BOTTOM VIEW

C, CASE
(FLANGE)

Pin 1 - Base
Pin 2 - Emitter



MOUNTING FLANGE—
Collector,
Case

AUDIO-FREQUENCY POWER AMPLIFIER SERVICE

Maximum and Minimum Ratings, *Absolute-Maximum Values*:

Collector-to-Base Voltage V_{CBO} -60 max. volts
With emitter open

Collector-to-Emitter Voltage. V_{CEO} -40 max. volts
With base open

Emitter-to-Base Voltage V_{EBO} -1.5 max.^a volts ←
With collector open

Collector Current I_C -5 max. amp

Emitter Current I_E 5 max. amp

Base Current. I_B -1 max. amp

Transistor Dissipation

Average:

At mounting-flange temperature^b

From -65° to 81° C. P_T 12.5 max. watts

Above 81° C. Derate linearly 0.66 watt/°C

Peak:

Determined by operating

conditions. See *Collector Characteristics Curves*

Temperature

Operating range (Junction). T_{opr} -65 to 100 °C ←

Storage range T_{stg} -65 to 100 °C

Pins^c (During soldering):

For 10 seconds maximum. T_p 225 max. °C

← Indicates a change.



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DATA 1
1-64

ELECTRICAL CHARACTERISTICS

Mounting-flange temperature^b = 25° C, unless otherwise specified

Min. Typ. Max.

DC Collector-to-Base				
Breakdown Voltage . . . BV _{CBO}	-60	-	-	volts
I _C = -10 ma., I _E = 0				
DC Collector-to-Emitter				
Breakdown Voltage . . BV _{CEO}	-40	-	-	volts
I _C = -100 ma., I _B = 0				
DC Base-to-Emitter				
Voltage V _{BE}	-	-0.26	-	volt
V _{CE} = -10 volts, I _C = -50 ma.				
DC Collector-Cutoff				
Current I _{CBO}	-	-	-1	ma
V _{CB} = -40 volts, I _E = 0				
DC Emitter-Cutoff				
Current I _{EBO}	-	-	-10	ma
V _{EB} = -1.5 volts, I _C = 0				
DC Collector-Cutoff				
Saturation Current. I _{CBO} (sat)	-	-	-100	μa
V _{CB} = -0.5 volt, I _E = 0				
DC Forward-Current				
Transfer Ratio. . . . h _{FE}	60	100		
V _{CE} = -1 volt, I _C = -1 ampere				
Gain-Bandwidth				
Product f _T	-	3	-	Mc
V _{CE} = -5 volts, I _C = -0.5 ampere				
Thermal Resistance. . . θ _{JMF}	-	-	1.5	°C/watt
Junction-to-mounting-flange				

→ Typical Operation:

In accompanying class A AF-amplifier circuit at mounting-flange temperature^b of 25° C

DC Collector Supply Voltage (V _{CC})	-16	volts
DC Collector-to-Emitter Voltage	-13.2	volts
DC Collector Current.	-0.9	amp
Peak Collector Current.	-1.8	amp
Input Impedance	10	ohms
Collector Load Impedance.	15	ohms
Maximum Collector Dissipation	12	watts
Power Gain.	36	db

→ Indicates a change.



Total Harmonic Distortion.	5	%
Maximum-Signal Power Output.	5	watts
<i>In accompanying "single-ended push-pull" class B AF-amplifier circuit at mounting-flange temperature^b of 25° C</i>		
Unless otherwise specified, values are for 2 transistors		
DC Collector Supply Voltage (V_{CC}) ^d	-16.5	volts
Zero-Signal Base-Bias Voltage.	-0.26	volt
Zero-Signal DC Collector Current	-0.05	amp
Maximum-Signal DC Collector Current.	-0.85	amp
Peak Collector Current	-2.7	amp
Input Impedance of Stage (Per base).	65	ohms
Load Impedance (Speaker voice-coil).	4	ohms
Maximum Collector Dissipation (Per transistor under worst-case conditions)	7.5	watts
Power Gain	31	db
Total Harmonic Distortion.	5	%
Music Power Output ^e	25	watts
Maximum-Signal Power Output.	15	watts

^a This rating may be exceeded provided the combined dissipation in the emitter and the collector does not exceed the maximum dissipation rating for the device, and provided the driver stage (transformer coupled) is capable of providing the emitter-to-base current drawn by the transistors under the emitter-to-base voltage conditions (reverse-bias) shown.

^b Measured at center of seating plane.

^c Measured along pin at distances not less than 1/16" down from seating plane.

^d The data shown are for a dc collector supply having 10 per cent regulation.

^e Determined according to EIA Standard RS234, Section 2.1.2.1.

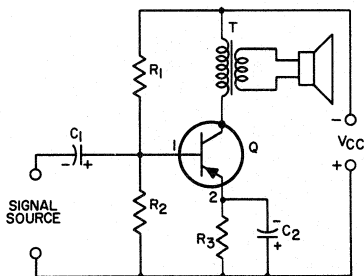
OPERATING CONSIDERATIONS and SUGGESTED MOUNTING ARRANGEMENT

shown under type 2N2147 also apply to the 2N2148



2N2148

CLASS A AF AMPLIFIER-STAGE CIRCUIT



92CS-11333R2

C_1 : Value determined by signal-source impedance.

C_2 : 5000 μ f, 3 volts, electrolytic

Q: Transistor type 2N2148

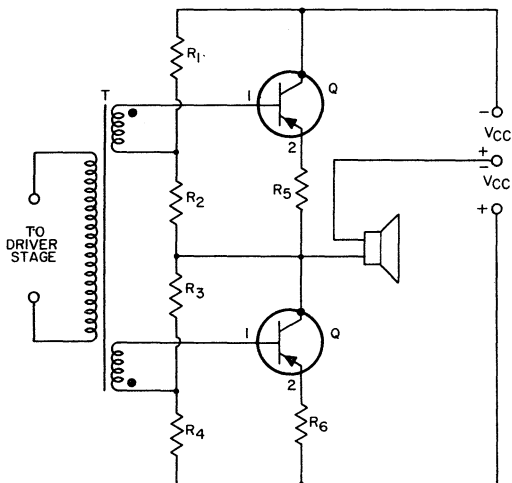
R_1 : 120 ohms $\pm$ 10%, 2 watts

R_2 : 22 ohms $\pm$ 10%, 0.5 watt

R_3 : 2.2 ohms $\pm$ 10%, 2 watts

T: Output transformer for matching of speaker voice coil to 15-ohm collector load impedance; primary-winding current = 1 ampere dc, primary-winding dc resistance = 1 ohm max.

"SINGLE-ENDED PUSH-PULL" CLASS B AF AMPLIFIER-STAGE CIRCUIT



92CS-11332R2

- Q: Transistor type 2N2148
 R_1, R_3 : 270 ohms $\pm 10\%$, 2 watts
 R_2, R_4 : 3.9 ohms $\pm 10\%$, 0.5 watt
 R_5, R_6 : 0.39 ohm $\pm 10\%$, 0.5 watt
 Speaker: Voice-Coil Impedance . . 4 ohms
 T: Driver Transformer. Primary-winding impedance, current-carrying capacity, and dc resistance determined by large-signal characteristics of driver stage; secondary windings bifilar wound, impedance of each winding = 100 ohms.

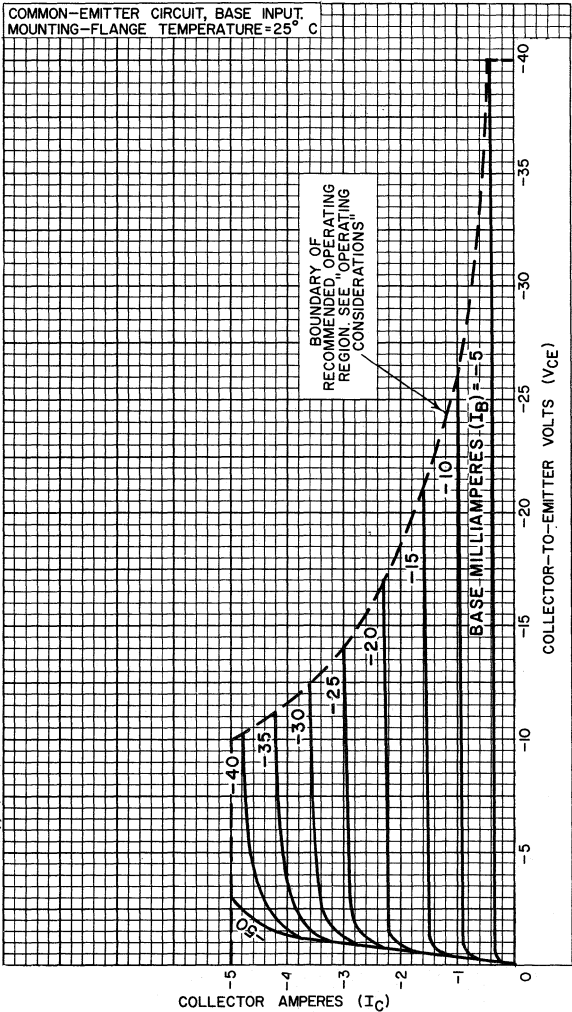
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DATA 3
 1-64

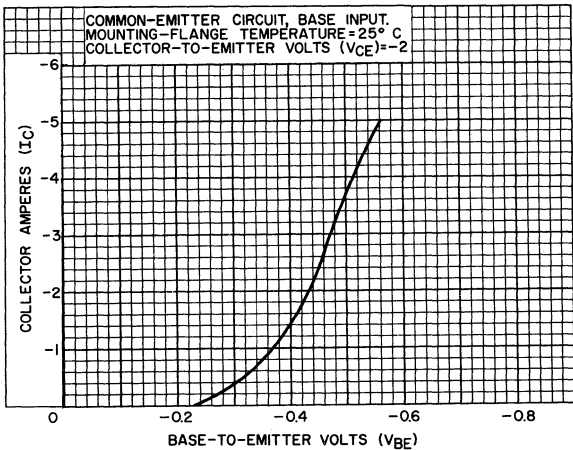
TYPICAL COLLECTOR CHARACTERISTICS



92CM-10999R3

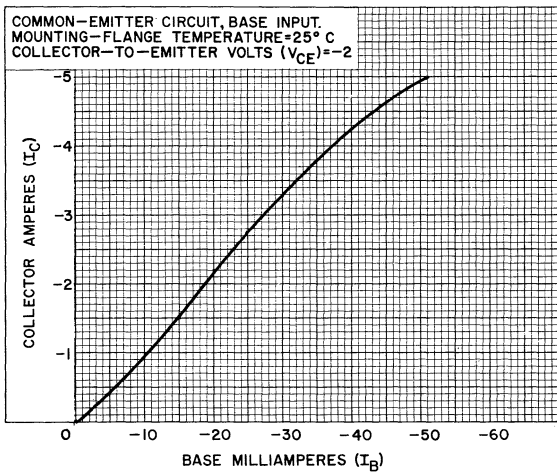


TYPICAL TRANSFER CHARACTERISTIC



92CS-11324RI

TYPICAL CURRENT-TRANSFER CHARACTERISTIC

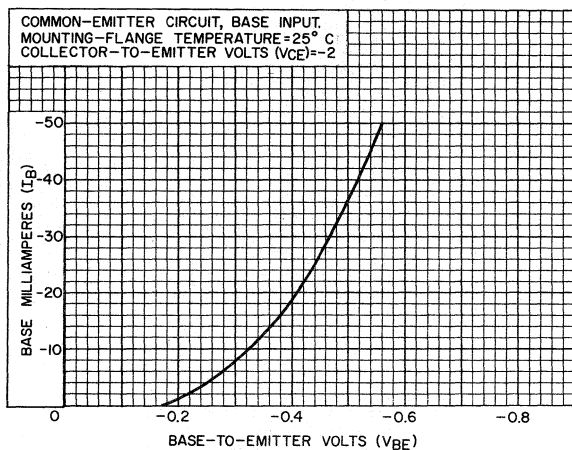


92CS-10993RI



2N2148

TYPICAL INPUT CHARACTERISTIC



92CS-11329RI



Transistor

SILICON N-P-N DOUBLE-DIFFUSED-JUNCTION EPITAXIAL-PLANAR TYPE
 For Switching Applications in In-
dustrial and Military Equipment

The 2N2205 is the same as the 2N1708 except for the following items:

GENERAL DATA

Mechanical:

Dimensions. See Outline T0-18 in General Section

ELECTRICAL CHARACTERISTICS

	Min.	Max.	
DC Emitter-Cutoff Current for dc emitter-to-base volts = 3, collector current = 0. I_{EBO}	-	100	μa ←

← Indicates a change.



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DATA
 8-63

Transistor

SILICON N-P-N TRIPLE-DIFFUSED-JUNCTION PLANAR TYPE

For Industrial and Military Applications

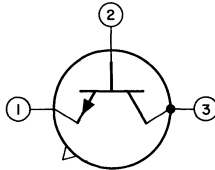
GENERAL DATA

Mechanical:

Dimensions. See *Outline TO-5* in General Section
 Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter

Lead 2 - Base

Lead 3 - Collector,
Case

INDUSTRIAL SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CBO} 60 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With external resistance
 (ohms) ≤ 10 between base

and emitter. V_{CER} 60 max. volts
 With base open. V_{CEO} 45 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EBO} 7 max. volts

COLLECTOR CURRENT.

I_C 1 max. amp

TRANSISTOR DISSIPATION:^a

At case temperature^b of 25° C
 or below

5 max. watts

At free-air temperature of
 25° C or below

1 max. watt

TEMPERATURE RANGE:

Storage. T_{stg} -65 to +200 °C

Operating (Junction) T_J -65 to +200 °C

LEAD TEMPERATURE:^c

For 10 seconds maximum T_L 255 max. °C

^a See accompanying *Rating Chart*.^b Measured at center of seating plane.^c Measured 1/16" $\pm$ 1/32" down from seating plane.

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DATA 1

4-62

ELECTRICAL CHARACTERISTICS

Voltage values are given with respect to base and at case temperature^b of 25° C unless otherwise specified

Min. Max.

DC Collector Breakdown Voltage for dc collector ma. = 0.1, dc emitter ma. = 0	BV_{CBO}	60	—	volts
DC Emitter Breakdown Voltage for dc collector ma. = 0, dc emitter ma. = 0.1	BV_{EBO}	7	—	volts
DC Collector-to-Emitter Sustaining Voltage for dc collector ma. = 100 ^d : With external base-to-emitter resistance (ohms) ≤ 10	$V_{CER(sus)}$	60	—	volts
With base ma. = 0	$V_{CEO(sus)}$	45	—	volts
DC Base-to-Emitter Saturation Voltage for dc collector ma. = 150, dc base ma. = 15.	$V_{BE(sat)}$	—	1.2	volts
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 150, dc base ma. = 15	$V_{CE(sat)}$	—	0.9	volt
DC Collector-Cutoff Current for dc collector volts = 60, dc emitter ma. = 0, case temperature ^b = 25° C	I_{CBO}	—	0.1	μa
150° C		—	50	μa
DC Emitter-Cutoff Current for dc emitter volts = 5, dc collector ma. = 0	I_{EBO}	—	0.1	μa
Input Capacitance for dc emitter volts = 0.5, dc collector ma. = 0	C_{ib}	—	80	pf
Output Capacitance for dc collector volts = 10, dc emitter ma. = 0	C_{ob}	—	15	pf
Small-Signal Forward Current Transfer Ratio: With dc collector-to-emitter volts = 10, dc collector ma. = 5, frequency (kc) = 1	h_{fe}	30	180	
With dc collector-to-emitter volts = 10, dc collector ma. = 50, frequency (Mc) = 20		3	—	



DC Forward Current Transfer Ratio for dc collector-to-emitter volts = 10, dc collector ma. =	h_{FE}			
150 ^d		50	200	
1.		35	-	
Noise Figure for signal frequency of 1 kc, circuit bandwidth of 15 kc, generator resistance (ohms) = 1000, dc collector-to-emitter volts = 10, dc collector ma. = 0.3	NF	-	6	db
Thermal Resistance:				
Junction-to-case	θ_{J-C}	-	35	°C/watt
Junction-to-free air	θ_{J-FA}	-	175	°C/watt
^b Measured at center of seating plane.				
^d Pulsed duration, 300 microseconds; duty factor, 0.018.				

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

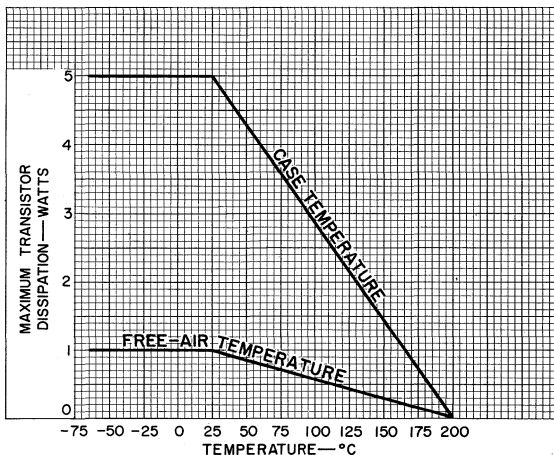
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

This transistor is intended for use in single-side printed-circuit boards and in conventional wire-in-type circuits. If this transistor is used in double-side printed-circuit boards or in printed-circuit boards utilizing eyelets, it may be necessary to use an insulating washer or similar standoff device made of good dielectric material to prevent the solder from shorting the leads to each other or to the board, and to prevent the collector from shorting to ground.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

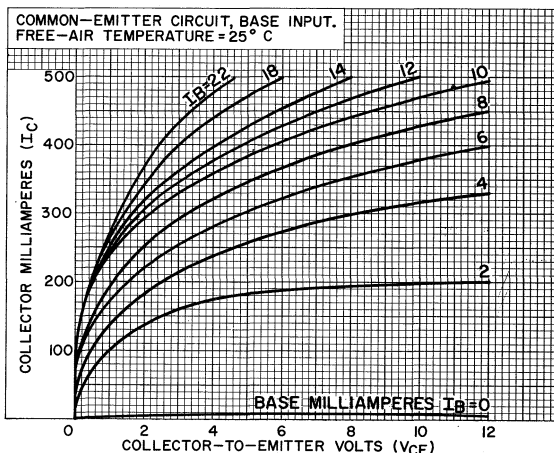


RATING CHART



92CS-III72RI

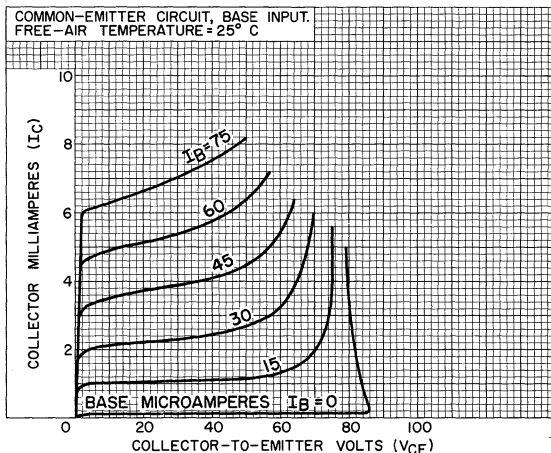
TYPICAL COLLECTOR CHARACTERISTICS



92CS-III89

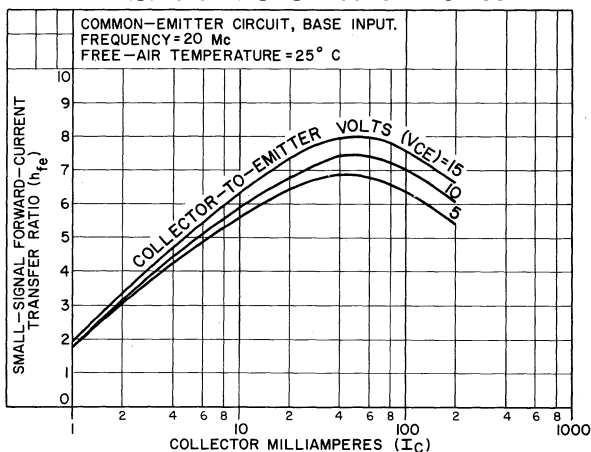


TYPICAL COLLECTOR CHARACTERISTICS



92CS-III75

TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



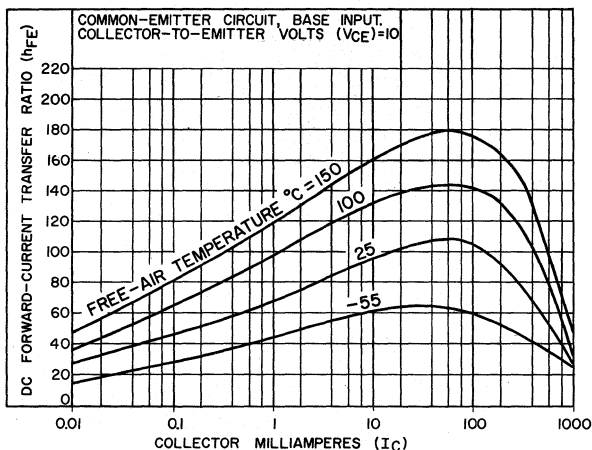
92CS-III71



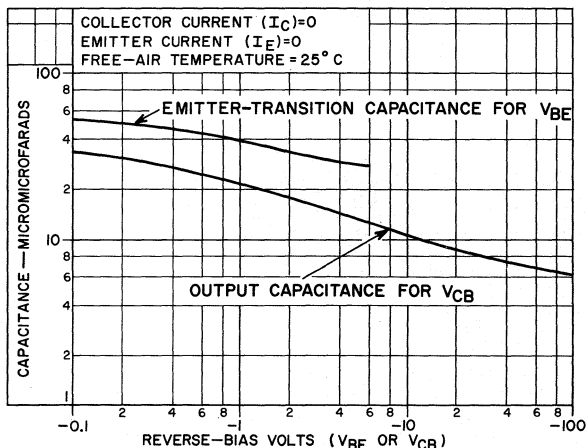
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DATA 3
4-62

TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS

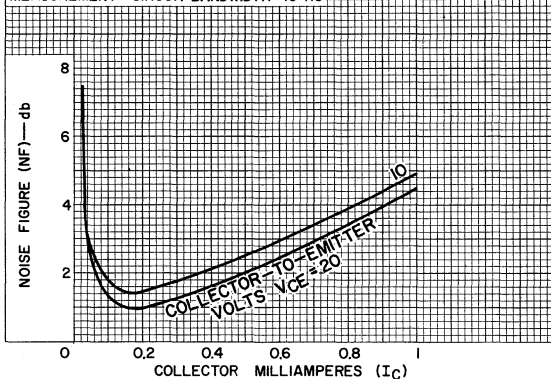


TYPICAL EMITTER-TRANSITION-CAPACITANCE AND OUTPUT-CAPACITANCE CHARACTERISTICS



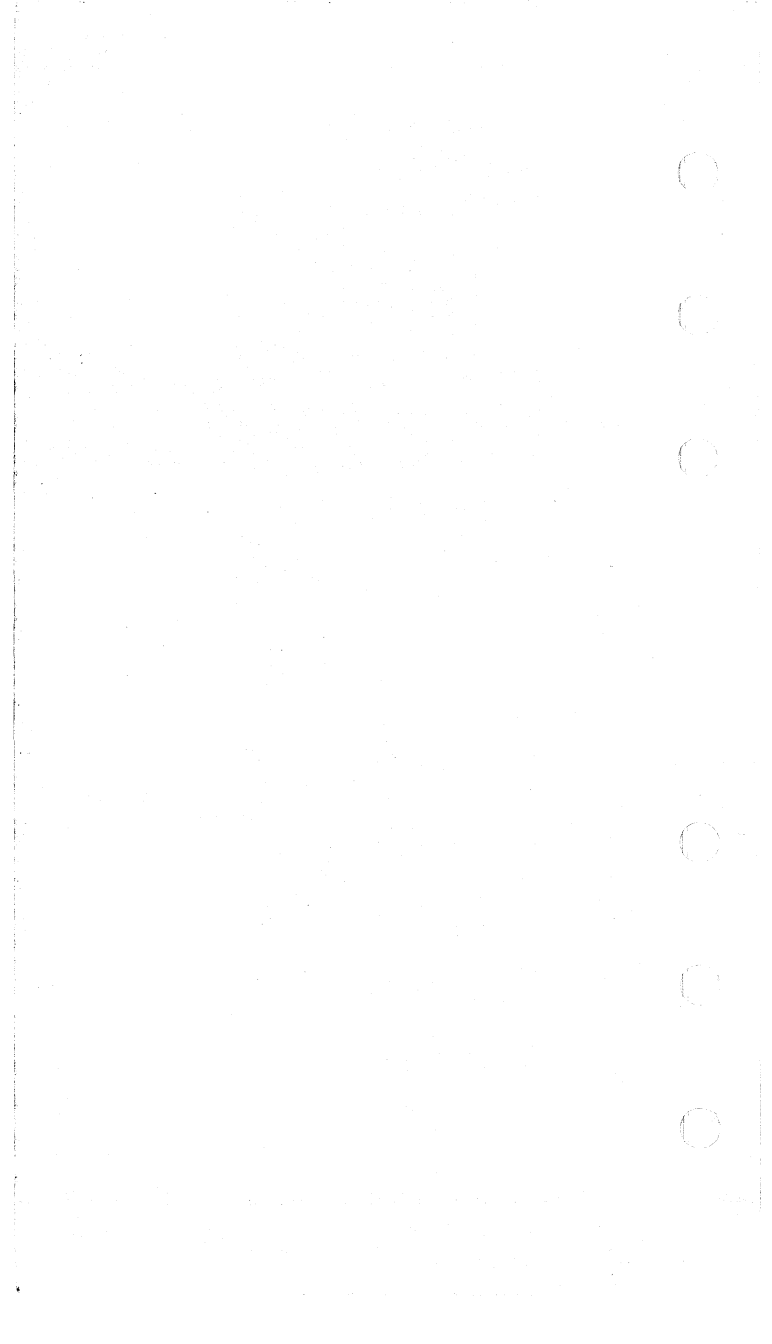
TYPICAL AF-NOISE-FIGURE CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE = 25° C
GENERATOR RESISTANCE = 1000 OHMS
SIGNAL FREQUENCY = 1 KC
MEASUREMENT - CIRCUIT BANDWIDTH = 15 KC



92CS-III79RI





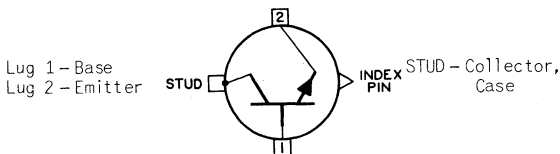
Power Transistor

SILICON N-P-N DIFFUSED-JUNCTION TYPE

For Power Switching Applications in
Industrial and Military Equipment

GENERAL DATA

Mechanical:

Dimensions. See Outline T0-36 in General Section
Terminal Diagram: BOTTOM VIEW

INDUSTRIAL SERVICE

Such as in dc-to-dc converter, inverter, chop-
per, voltage- and current-regulator, dc- and
servo-amplifier, and relay-actuating circuits

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} 60 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With emitter-to-base reverse

bias dc volts = 1.5 V_{CEV} 60 max. voltsWith base open (Sustaining
voltage) ^a $V_{CEO(sus)}$ 40 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EBO} 6 max. voltsCOLLECTOR CURRENT I_C 7.5 max. ampBASE CURRENT I_B 5 max. ampTRANSISTOR DISSIPATION: ^bAt case temperatures: ^c

From -65° to 25° C 150 max. watts

Above 25° C Derate linearly 0.855 watt/°C

TEMPERATURE:

Operating Range (Junction) T_{OPR} -65 to 200 °CStorage Range T_{STG} -65 to 200 °CLug: ^dFor 10 seconds maximum. T_L 235 max. °C

← Indicates a change.



ELECTRICAL CHARACTERISTICS

Unless otherwise specified, case temperature^b = 25° C

Min. Typ. Max.

DC Collector-to-Emitter

Voltage:

With emitter-to-base

reverse bias dc volts

= 1.5, dc collector

ma. = 2 V_{CEV} 60 - - volts

With base open (Sus-

taining voltage), dc

collector ma. = 200 $V_{CEO(sus)}^a$ 40 - - volts

DC Base-to-Emitter

Voltage for dc collec-

tor-to-emitter volts

= 4, dc collector

amperes = 3 V_{BE} - - 3 volts

→ DC Collector-to-Emitter

Saturation Voltage:

With dc collector

amperes = 6, dc base

amperes = 1 $V_{CE(sat)}$ - - 3.5 volts

With dc collector

amperes = 3, dc base

amperes = 0.3 $V_{CE(sat)}$ - - 1.5 volts

→ DC Collector-Cutoff

Current:

With dc collector-to-

emitter volts = 30,

base current = 0 I_{CEO} - - 5 ma

With dc collector-to-

emitter volts = 60,

base-to-emitter

reverse bias dc

volts = -1.5 I_{CEV} - - 2 ma

With dc collector-to-

emitter volts = 30,

base-to-emitter

reverse bias dc

volts = -1.5, case

temperature (°C) = 200 I_{CEX} - - 50 ma

With dc collector-to-

base volts = 30,

emitter current = 0,

case temperature =

25° C I_{CBO} - - 0.2 ma

150° C I_{CBO} - - 3 ma

DC Emitter-Cutoff Current

for dc emitter-to-base

volts = 6, collector

current = 0 I_{EBO} - - 0.1 ma

→ Indicates a change.



		Min.	Typ.	Max.	
DC Forward-Current Transfer Ratio for dc collector-to-emitter volts = 4, dc collector amperes = 3.	h_{FE}	15	-	60	←
6.	h_{FE}	7	-	-	
Small-Signal Short-Circuit Forward-Current Transfer Ratio for dc collector-to-emitter volts = 4, dc collector amperes = 0.5, frequency (kc) = 1.	h_{fe}	12	-	72	←
Small-Signal Short-Circuit Forward-Current Transfer Ratio Cutoff Frequency for dc collector-to-emitter volts = 4, dc collector amperes = 5.	f_{hfe}	0.015	-	-	← Mc
Collector-to-Emitter Saturation Resistance for dc collector amperes = 3, dc base amperes = 0.3.	$r_{CE(sat)}$	-	-	0.5	ohm
Collector-to-Base Capacitance for dc collector-to-base volts = 40, emitter current = 0, frequency (Mc) = 0.1.	C_{ob}	-	-	600	← pf
Thermal Time Constant.	τ_I	-	30	-	msec
Thermal Resistance: Junction-to-case.	θ_{JC}	-	-	1.17	°C/watt

Typical Operation:

In accompanying pulse-response test circuit at case temperature $c = 25^{\circ}C$

DC Collector Supply Voltage	V_{CC}	24	volts
DC Base Supply Voltage.	V_{BB}	-6	volts
"On" DC Collector Current	I_C	10	amp
"Turn-On" Base Current.	I_{BI}	2	amp
Base Resistance	R_{BI}	10	ohms
Base Resistance	R_{B2}	10	ohms
Collector Resistance.	R_C	2	ohms
Switching Time:			
"Turn-on" time [Delay time (t_d) + rise time (t_r)]	t_{on}	4	μsec
"Turn-off" time [Storage time (t_s) + fall time (t_f)]	t_{off}	7	μsec

← Indicates a change.



2N2338

- a The Collector-to-Emitter sustaining voltage [$V_{CE0(sus)}$] with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{aM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).
- b See *Transistor-Dissipation Rating Chart* in General Section.
- c Measured at intersection of seating plane with mounting stud.
- d Measured $1/16" \pm 1/32"$ along lug down from seating plane.

OPERATING CONSIDERATIONS

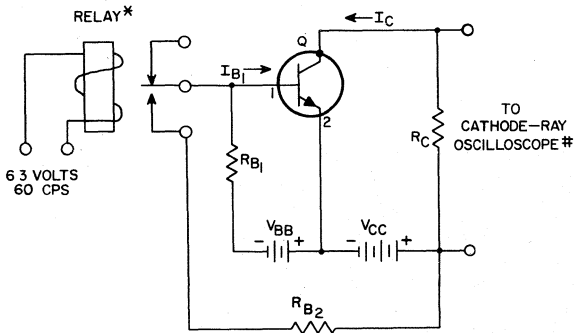
This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

Electrical connection can be made to the base and emitter lugs by means of clips or by soldering directly to the lugs. When soldering connections are made to the lugs, care should be taken to conduct excessive heat away from the lug seals, otherwise the heat of the soldering operation will crack the seals of the lugs and damage the transistor.

This transistor is provided with a single-ended stud for mounting to a heat sink and for electrical connection to the collector. (See accompanying *Suggested Mounting Arrangement*). Electrical connection to the base and to the emitter is made to their respective lugs.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

PULSE-RESPONSE TEST CIRCUIT



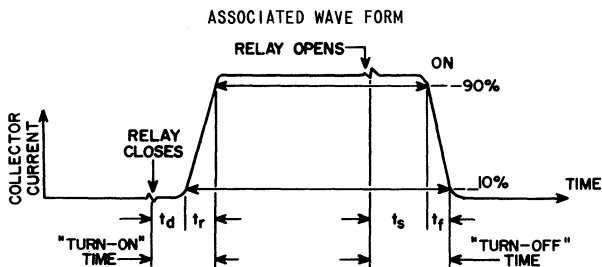
*C.P. CLARE TYPE HGP-1028
OR EQUIVALENT

#TEKTRONIX TYPE 545
OR EQUIVALENT

92CS-11125R2

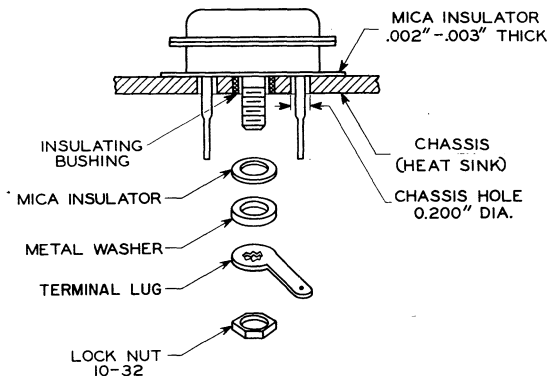
Q: Transistor type 2N2338





92CS-III26RI

SUGGESTED MOUNTING ARRANGEMENT



92CS-10624R3

THE INSULATED BUSHING, MICA INSULATORS, METAL WASHER, TERMINAL LUG, AND LOCK NUT ARE SUPPLIED WITH EACH TRANSISTOR.

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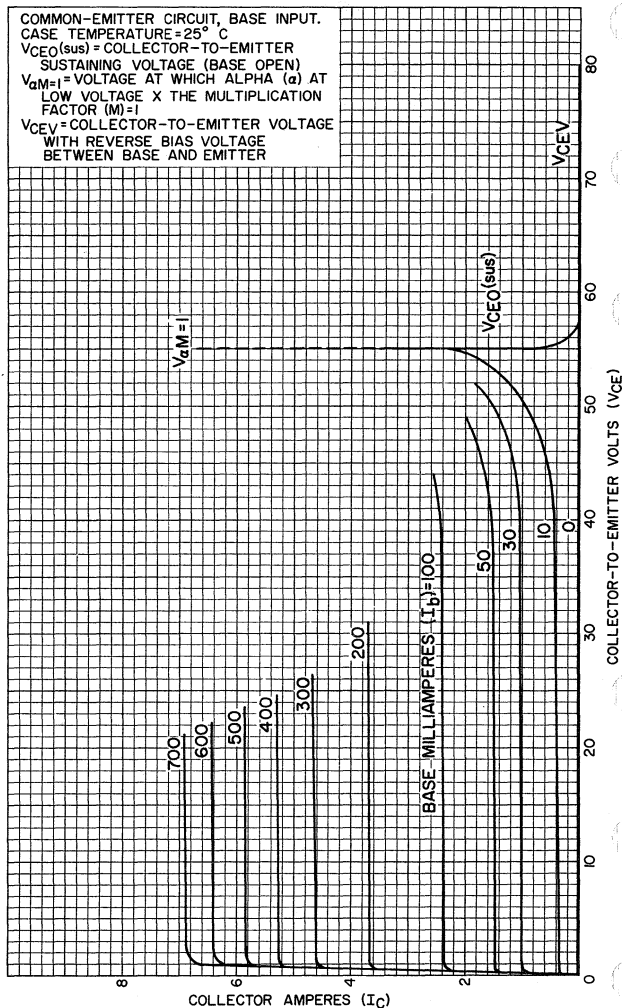
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DATA 3
8-63

2N2338

TYPICAL COLLECTOR CHARACTERISTICS



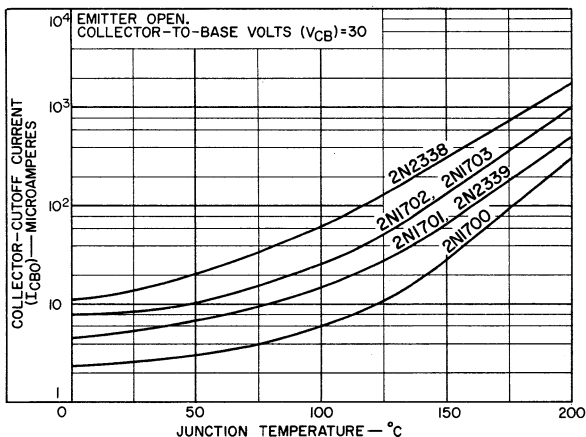
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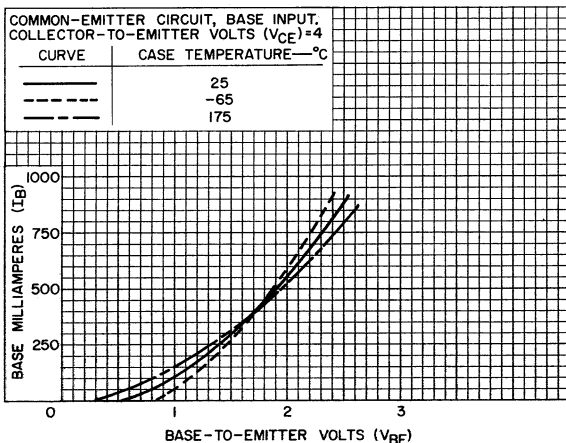


TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



92CS-11585

TYPICAL BASE CHARACTERISTICS

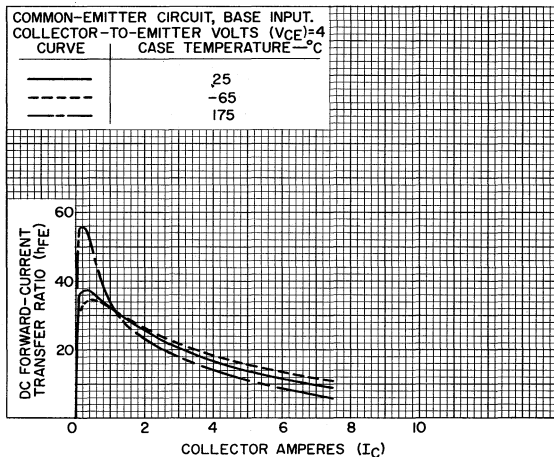


92CS-11568



2N2338

TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



92CS-11582



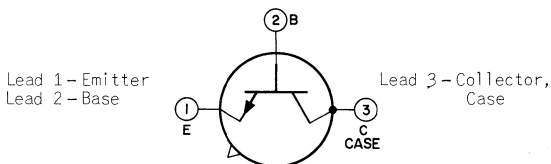
Computer Transistor

SILICON N-P-N EPITAXIAL-PLANAR TYPE

*For High-Speed Switching Applications in
Military and Commercial Digital Equipment*

MECHANICAL

Dimensions. See Outline TO-18 in General Section
TERMINAL DIAGRAM (Bottom View)



ABSOLUTE-MAXIMUM RATINGS

Collector-to-Base Voltage.	V_{CB0}	40	V
Collector-to-Emitter Voltage.	V_{CE0}	15	V
Emitter-to-Base Voltage.	V_{EB0}	4.5	V
Collector Current.	I_C	0.2	A

Transistor Dissipation

At case temperatures:^a

From -65 to 25°C	P_T	1.2	W
Above 25°C	Derate linearly	6.85 mW/°C	

At free-air temperatures:

From -65 to 25°C	P_T	0.36	W
Above 25°C	Derate linearly	2.06 mW/°C	

Temperature Range

Operating (Junction)	$T(\text{opr})$	-65 to 200	°C
Storage.	$T(\text{stg})$	-65 to 200	°C
Lead-Soldering Temperature ^b		300	°C

For 60 s max

ELECTRICAL CHARACTERISTICS

*Unless otherwise specified, electrode-voltage
and electrode-current values for given test
conditions are dc at free-air temperatures = 25°C*

Collector-to-Base Breakdown Voltage. .	BV_{CB0}	40 min	V
$I_C = 0.01 \text{ mA}, I_E = 0$			
Collector-to-Emitter Breakdown Voltage	BV_{CES}	40 min	V
$I_C = 0.01 \text{ mA}, V_{EB} = 0$			
Emitter-to-Base Breakdown Voltage. .	BV_{EB0}	4.5 min	V
$I_E = 0.01 \text{ mA}, I_C = 0$			
Collector-to-Emitter Sustaining Voltage ^c	$V_{CE0}(\text{sus})$	15 min	V
$I_C = 10 \text{ mA}, I_B = 0$			



2N2369A

Base-to-Emitter Saturation Voltage

$I_C = 10 \text{ mA}, I_B = 1 \text{ mA}$	$V_{BE}(\text{sat})$	$\begin{cases} 0.7 \text{ min} \\ 0.85 \text{ max} \end{cases}$	$\begin{matrix} V \\ V \end{matrix}$
$I_C = 10 \text{ mA}, I_B = 1 \text{ mA}, T_A = 125^\circ\text{C}$	$V_{BE}(\text{sat})$	0.59 min	V
$I_C = 10 \text{ mA}, I_B = 1 \text{ mA}, T_A = -55^\circ\text{C}$	$V_{BE}(\text{sat})$	1.02 max	V
$I_C = 30 \text{ mA}, I_B = 3 \text{ mA}$	$V_{BE}(\text{sat})$	1.15 max	V
$I_C = 100 \text{ mA}, I_B = 10 \text{ mA}$	$V_{BE}(\text{sat})$	1.6 max	V

Collector-to-Emitter Saturation Voltage

$I_C = 10 \text{ mA}, I_B = 1 \text{ mA}$	$V_{CE}(\text{sat})$	0.2 max	V
$I_C = 10 \text{ mA}, I_B = 1 \text{ mA}, T_A = 125^\circ\text{C}$	$V_{CE}(\text{sat})$	0.3 max	V
$I_C = 30 \text{ mA}, I_B = 3 \text{ mA}$	$V_{CE}(\text{sat})$	0.25 max	V
$I_C = 100 \text{ mA}, I_B = 10 \text{ mA}$	$V_{CE}(\text{sat})$	0.5 max	V

Collector-Cutoff Current

$V_{CB} = 20 \text{ V}, I_F = 0, T_A = 150^\circ\text{C}$	I_{CB0}	30 max	μA
---	-----------	--------	---------------

Collector-Cutoff Current

$V_{CE} = 20 \text{ V}, R_{BE} = 0$	I_{CES}	0.4 max	μA
-------------------------------------	-----------	---------	---------------

DC Forward Current-Transfer Ratio^c

$V_{CE} = 0.35 \text{ V}, I_C = 10 \text{ mA}$	h_{FE}	40 min	
$V_{CE} = 1 \text{ V}, I_C = 10 \text{ mA}$	h_{FE}	120 max	
$V_{CE} = 0.4 \text{ V}, I_C = 30 \text{ mA}$	h_{FE}	30 min	
$V_{CE} = 0.35 \text{ V}, I_C = 10 \text{ mA}, T_A = -55^\circ\text{C}$	h_{FE}	20 min	
$V_{CE} = 1 \text{ V}, I_C = 100 \text{ mA}$	h_{FE}	20 min	

Small-Signal Forward Current-

Transfer Ratio	h_{fe}	5 min	
--------------------------	----------	-------	--

$f = 100 \text{ Mc/s}, V_{CE} = 10 \text{ V}, I_C = 10 \text{ mA}$

Output Capacitance

$f = 0.14 \text{ Mc/s}, V_{CB} = 5 \text{ V}, I_E = 0$	C_{obo}	4 max	pF
--	-----------	-------	----

Storage Time

$V_{CC} = 10 \text{ V}, I_C = 10 \text{ mA},$ $I_{B1} = 10 \text{ mA}, I_{B2} = -10 \text{ mA}$	t_s	13 max	ns
--	-------	--------	----

Turn-Off Time ($t_s + t_f$)

$V_{CC} = 3 \text{ V}, I_C = 10 \text{ mA},$ $I_{B1} = 3 \text{ mA}, I_{B2} = -1.5 \text{ mA}$	t_{off}	18 max	ns
---	-----------	--------	----

Turn-On Time ($t_d + t_r$)

$V_{CC} = 3 \text{ V}, I_C = 10 \text{ mA},$ $I_{B1} = 3 \text{ mA}, V_{BE}(\text{off}) = -3 \text{ V}$	t_{on}	12 max	ns
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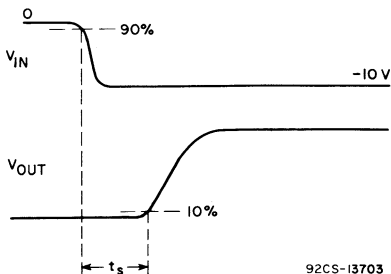
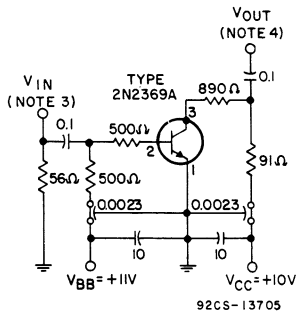
^a Measured at center of seating surface.

^b Measured along lead at distances $\geq 1/16$ inch from seating surfaces.

^c Pulse duration = 300 μs ; duty factor ≤ 0.02 .



STORAGE TIME TEST CIRCUIT AND WAVEFORMS



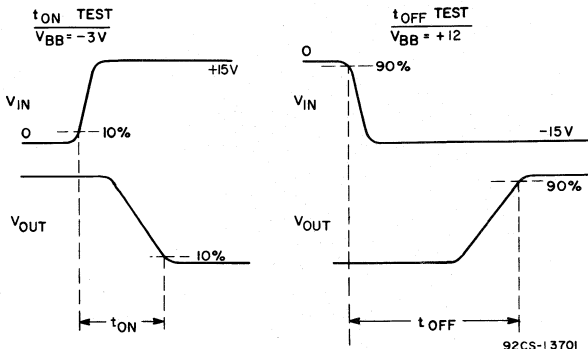
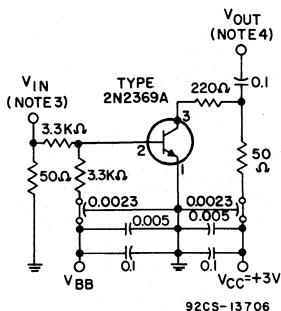
See reverse side for Notes.



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DATA 2
2-66

SWITCHING TIME TEST CIRCUIT AND WAVEFORMS



Note 1: All resistance values have ± 1 percent tolerance; all capacitance values are in μF .

Note 2: With certain types of power supplies, it may be necessary to connect 25- μF decoupling capacitors across the power-supply terminals for V_{CC} and V_{BB} .

Note 3: Input voltage (V_{IN}) obtained from mercury-relay type pulse generator having an output impedance of 50 ohms. V_{IN} rise time $< 1\text{ ns}$; pulse duration $> 200\text{ ns}$; and duty factor < 0.02 .

Note 4: Input and output waveforms monitored by means of a sampling oscilloscope having a rise time $< 1\text{ ns}$ and with a probe having a series resistance of $\geq 100\text{ K}\Omega$ shunted by capacitance of $< 2.5\text{ pF}$.

Transistor

SILICON N-P-N TRIPLE-DIFFUSED-JUNCTION PLANAR TYPE

For Small-Signal and Medium-Power Applications in Industrial and Military Equipment

GENERAL DATA

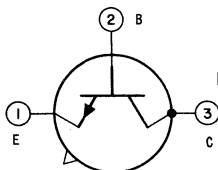
Mechanical:

Dimensions. See *Outline To-5* in General Section

Terminal Diagram:

BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

INDUSTRIAL SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With base-to-emitter reverse

bias dc volts = -1.5 V_{CBV} 120 max. volts

With emitter open. V_{CBO} 120 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With external base-to-emitter

resistance (ohms) =

< 10 V_{CER} 140 max. volts

500 V_{CER} 120 max. volts

With base open V_{CEO} 90 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EBO} 7 max. volts

COLLECTOR CURRENT. I_C 1 max. amp

TRANSISTOR DISSIPATION:

At case temperatures:^a

From -65° to 25° C 5 max. watts

Above 25° C Derate linearly $0.0286 \text{ watt}/^{\circ}\text{C}$

At free-air temperatures:

From -65° to 25° C 1 max. watt

Above 25° C Derate linearly $0.00572 \text{ watt}/^{\circ}\text{C}$

TEMPERATURE:

Operating range (Junction) T_{opr} -65 to 200°C

Storage range. T_{stg} -65 to 200°C

Lead:^b

For 10 seconds maximum T_L 255 max. $^{\circ}\text{C}$



2N2405

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, case temperature^a = 25°C

		Min.	Max.	
DC Collector-to-Base Breakdown Voltage for dc collector ma. = 0.1, emitter current = 0. . .	BV_{CBO}	120	-	volts
DC Collector-to-Emitter Breakdown Voltage for external base-to-emitter resistance (ohms) = 10.	BV_{CER}	140	-	volts
DC Emitter-to-Base Breakdown Voltage for dc emitter ma. = 0.1, collector current = 0. . .	BV_{EBO}	7	-	volts
DC Collector-to-Emitter Sustaining Voltage: With pulsed-dc collector ma. = 100c, external base-to-emitter resistance (ohms) = 10	$V_{CER(sus)}$	140	-	volts
500.	$V_{CER(sus)}$	120	-	volts
With base open, pulsed-dc collector ma. = 100c	$V_{CEO(sus)}$	90	-	volts
30c.	$V_{CEO(sus)}$	90	-	volts
DC Base-to-Emitter Saturation Voltage: With pulsed-dc collector ma. = 150c, pulsed-dc base ma. = 15c.	$V_{BE(sat)}$	-	1.1	volts
With pulsed-dc collector ma. = 50c, pulsed-dc base ma. = 5c	$V_{BE(sat)}$	-	0.9	volt
DC Collector-to-Emitter Saturation Voltage: With pulsed-dc collector ma. = 150c, pulsed-dc base ma. = 15c.	$V_{CE(sat)}$	-	0.5	volt
With pulsed-dc collector ma. = 50c, pulsed-dc base ma. = 5c	$V_{CE(sat)}$	-	0.2	volt
DC Collector-Cutoff Current for dc collector-to-base volts = 90, emitter current = 0, case temperature (°C) = 25	I_{CBO}	-	0.01	μa
150.	I_{CBO}	-	10	μa
DC Emitter-Cutoff Current for dc emitter-to-base volts = 5, collector current = 0 . .	I_{EBO}	-	0.01	μa
Input Impedance at frequency (kc) = 1: With dc collector-to-base volts = 5, dc collector ma. = 1.	h_{ib}	24	34	ohms
With dc collector-to-base volts = 10, dc collector ma. = 5	h_{ib}	4	8	ohms



	<i>Min.</i>	<i>Max.</i>	
Input Capacitance for dc emitter-to-base volts = 0.5, collector current = 0.	C_{ib}	-	80 pf
Output Capacitance for dc collector-to-base volts = 10, emitter current = 0	C_{ob}	-	15 pf
Output Conductance at frequency (kc) = 1:			
With dc collector-to-base volts = 5, dc collector ma. = 1	h_{ob}	-	0.5 μ ho
With dc collector-to-base volts = 10, dc collector ma. = 5	h_{ob}	-	0.5 μ ho
DC Forward-Current Transfer Ratio for dc collector-to-emitter volts = 10, pulsed-dc collector ma. ^c =			
10	h_{FE}	35	-
150.	h_{FE}	60	200
500.	h_{FE}	25	-
10, case temperature ($^{\circ}$ C) = -55.	h_{FE}	20	-
Small-Signal Short-Circuit Forward-Current Transfer Ratio:			
With dc collector-to-emitter volts = 5, dc collector ma. = 5, frequency (kc) = 1	h_{fe}	50	275
With dc collector-to-emitter volts = 10, dc collector ma. = 50, frequency (Mc) = 20.	h_{fe}	6	-
Small-Signal Open-Circuit Reverse Voltage Transfer (Feedback) Ratio at frequency (kc) = 1:			
With dc collector-to-base volts = 5, dc collector ma. = 1	h_{rb}	-	0.0003
With dc collector-to-base volts = 10, dc collector ma. = 5	h_{rb}	-	0.0003
Noise Figure (Wide band) for circuit bandwidth (kc) = 15, reference signal-frequency (kc) = 1, generator resistance (ohms) = 500, dc collector-to-emitter volts = 10, dc collector ma. = 0.3.	NF	-	6 db



2N2405

		Min.	Max.	
Thermal Resistance:				
Junction-to-case	θ_{JC}	-	35	$^{\circ}\text{C}/\text{watt}$
Junction-to-free-air	θ_{JFA}	-	175	$^{\circ}\text{C}/\text{watt}$

^a Measured at center of seating plane.

^b Measured $1/16" \pm 1/32"$ along lead from seating plane.

^c Pulse duration of 300 μsec , duty factor of 0.018.

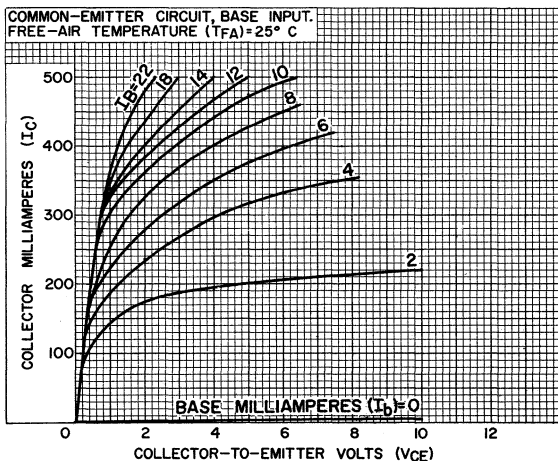
OPERATING CONSIDERATIONS

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

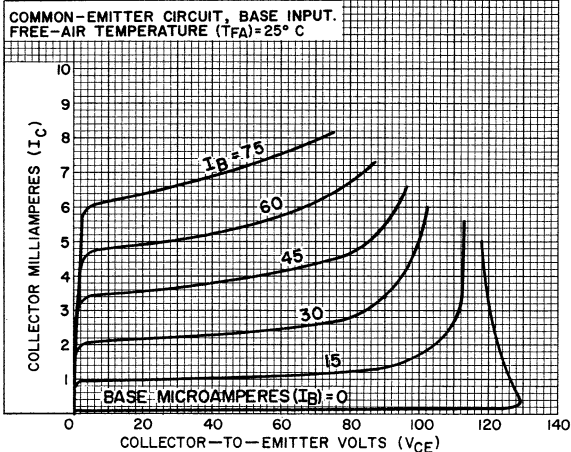
TYPICAL COLLECTOR CHARACTERISTICS



92CS-11176

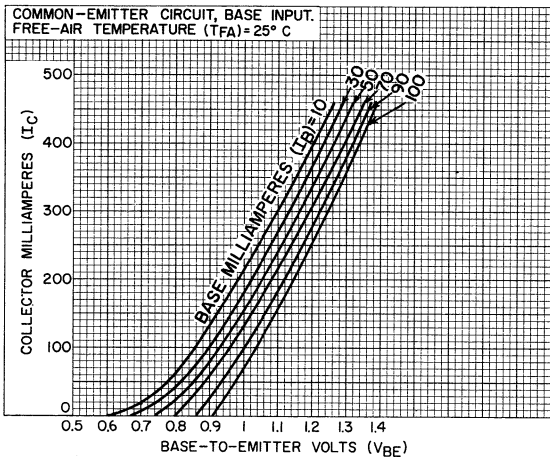


TYPICAL COLLECTOR CHARACTERISTICS



92CS 11647

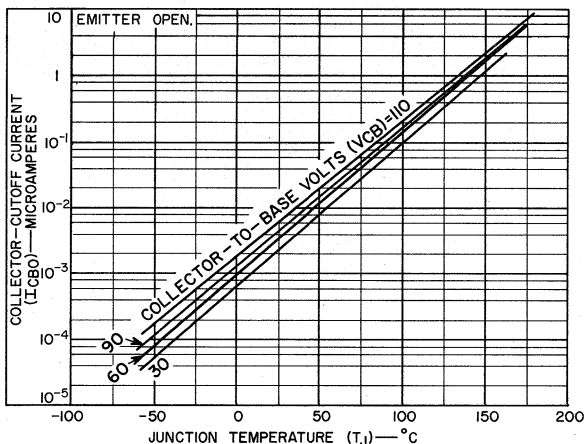
TYPICAL TRANSFER CHARACTERISTICS



92CS-11185

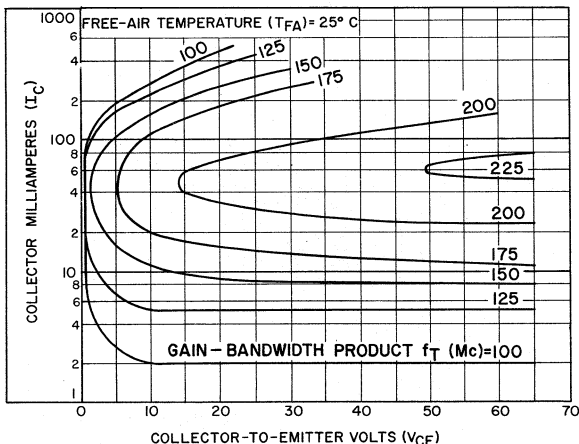


TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



92CS-11170RI

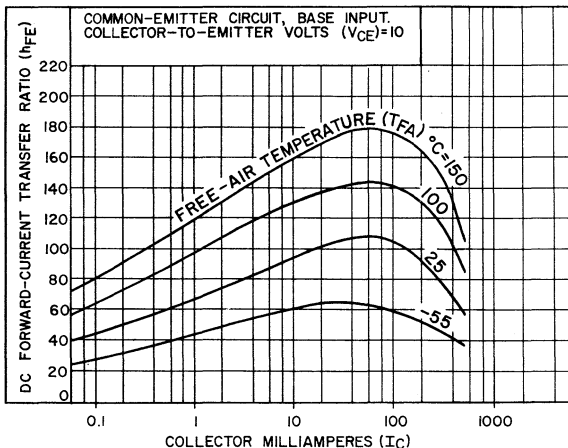
TYPICAL GAIN-BANDWIDTH-PRODUCT CHARACTERISTICS



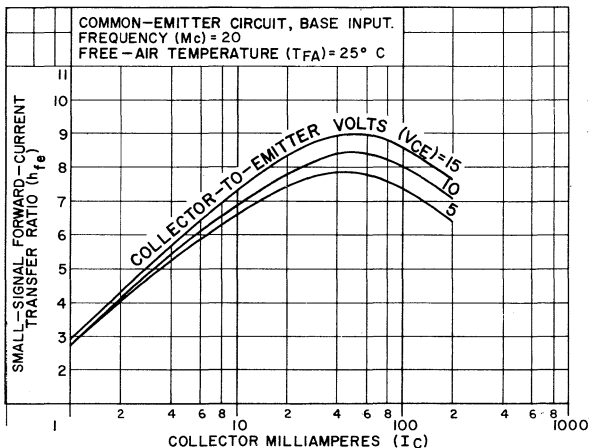
92CS 11660



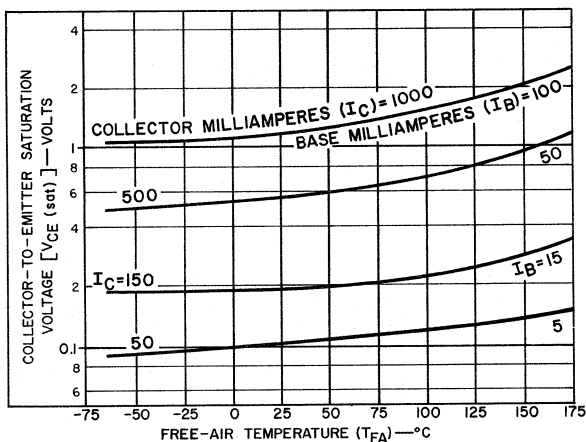
TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS

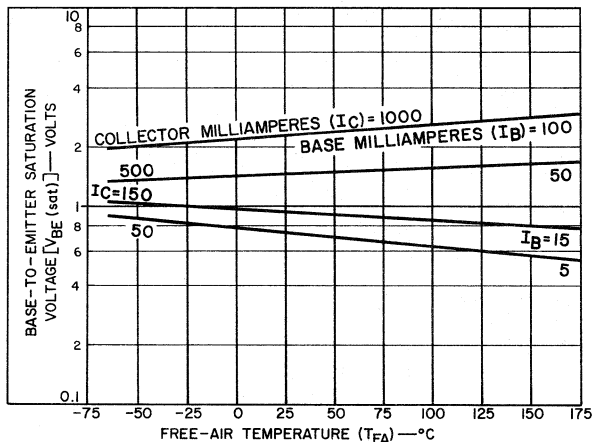


TYPICAL COLLECTOR-TO-EMITTER SATURATION-VOLTAGE CHARACTERISTICS



92CS 11652

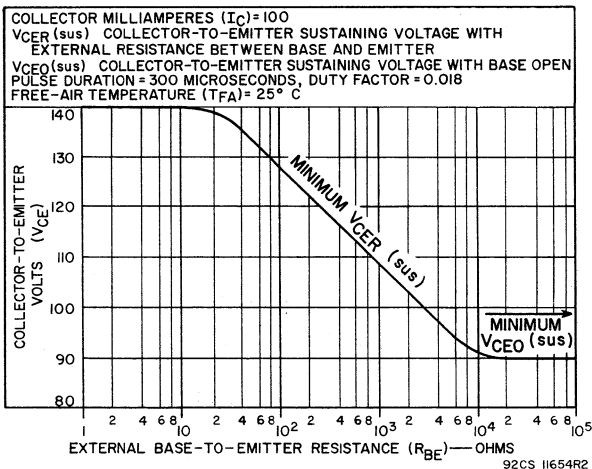
TYPICAL BASE-TO-EMITTER SATURATION-VOLTAGE CHARACTERISTICS



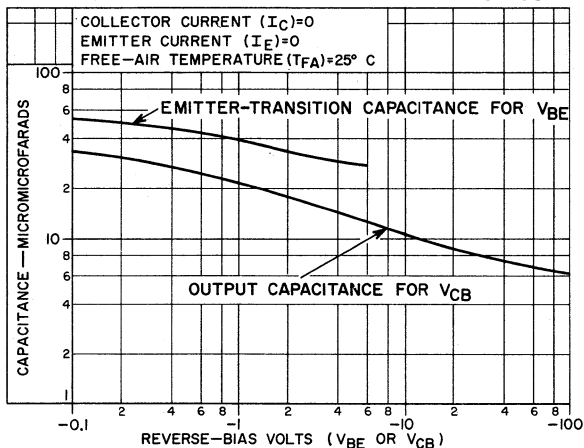
92CS 11651



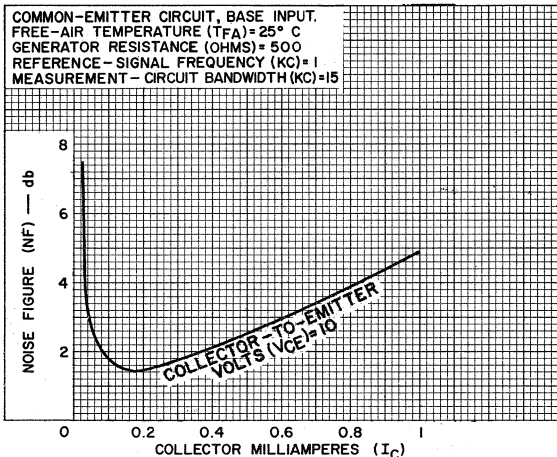
COLLECTOR-TO-EMITTER VOLTAGE CHARACTERISTICS



TYPICAL CAPACITANCE CHARACTERISTICS

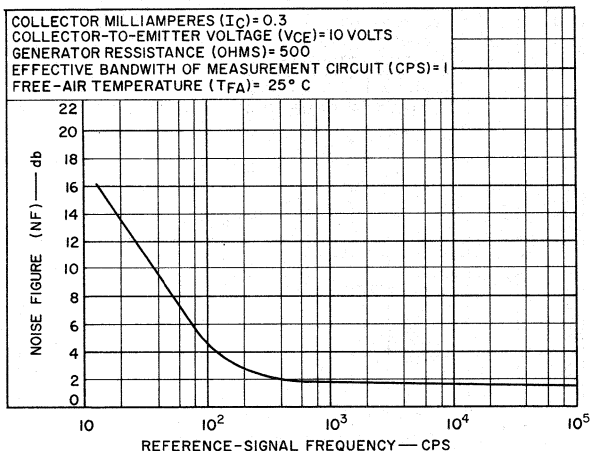


TYPICAL WIDE-BAND-NOISE CHARACTERISTIC



92CS 11656

TYPICAL NARROW-BAND-NOISE CHARACTERISTIC



92CS 11657



Transistor

SILICON N-P-N EPITAXIAL-PLANAR TYPE

For Ultra-High-Speed Logic-Circuit Switching Applications
in Commercial and Military Data-Processing Systems

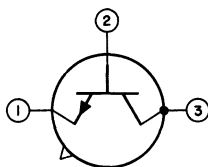
GENERAL DATA

Mechanical:

Dimensions. Similar to JEDEC No. TO-18

Terminal Diagram: BOTTOM VIEW

Lead 1—Emitter
Lead 2—Base



Lead 3—Collector,
Case

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CB0} 15 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With base open. V_{CE0} 6 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EB0} 4 max. volts

COLLECTOR CURRENT I_C Limited by power
dissipation

TRANSISTOR DISSIPATION:^a

P

At case temperature^b of

100° C or below 500 max. mw

At free-air temperature of

25° C or below. 300 max. mw

TEMPERATURE RANGE:

Junction (Operating). T_J -65 to +200 °C

Storage T_{STG} -65 to +300 °C

LEAD TEMPERATURE:^c

For 10 seconds maximum. T_L 300 max. °C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, free-air temperature = 25° C

Min. Typical Max.

DC Collector Breakdown Voltage

for dc collector ma. = 0.01,

dc emitter current = 0. . . BV_{CB0} 15 30 - volts

^a See accompanying Rating Chart.

^b Measured at center of seating plane.

^c Measured 1/16" ± 1/32" along lead, down from seating plane.



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DATA 1
8-62

Min. Typical Max.

DC Emitter Breakdown Voltage for dc collector current = 0, dc emitter ma. = 0.01.	BV_{EBO}	4	7	-	volts
DC Collector-to-Emitter Sustaining Voltage ^d for dc pulsed collector ma. = 10, dc base current = 0	$V_{CEO}(I_{sus})$	6	10	-	volts
DC Base-to-Emitter Saturation Voltage for dc collector ma. = 20, dc base ma. = 0.66.	$V_{BE}(sat)$	0.8	0.9	1	volt
DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 20, dc base ma. = 0.66.	$V_{CE}(sat)$	-	0.28	0.4	volt
DC Collector-Cutoff Current for dc collector-to-base volts = 5, dc emitter current = 0, free-air temperature = 25° C	I_{CBO}	-	0.002	0.05	μa
150° C.		-	0.9	5	μa
Emitter-to-Base Capacitance for dc emitter-to-base volts = -0.5, dc collector current = 0, frequency (kc) = 140 (Approx.)	C_{ib}	-	2	2.5	pf
Collector-to-Base Capacitance for dc collector-to-base volts = 5, dc emitter current = 0, frequency (kc) = 140 (Approx.)	C_{ob}	-	2.4	3	pf
DC Forward-Current Transfer Ratio: With dc collector-to- emitter volts = 0.3, dc collector ma. = 1	h_{FE}	20	40	-	
With dc collector-to- emitter volts = 0.5, dc pulsed collector ma. = 50.		20	36	-	
With dc collector-to- emitter volts = 0.4, dc pulsed collector ma. = 20.		30	50	150	
With dc collector-to- emitter volts = 0.4, dc pulsed collector ma. = 20, free-air temperature = -55° C.		15	24	-	
Small-Signal Short-Circuit Forward-Current Transfer Ratio for dc collector-to- emitter volts = 2, dc collector ma. = 20, signal frequency (Mc) = 100.	h_{fe}	6	8	-	



Switching Time:

Storage time^e for dc

collector ma. = 5, turn-

on dc base ma. = 5, turn-

off dc base ma. = -5. . .

 t_s - 3.2 6 nsecTurn-On time^f (Delay time

+ rise time) for dc col-

lector ma. = 20, turn-on

dc base ma. = 1, turn-off

dc base ma. = -1.

 t_{on} - 7.3 20 nsecTurn-Off time^f (Storage

time + fall time) for dc

collector ma. = 20, turn-

on dc base ma. = 1, turn-

off dc base ma. = -1. . .

 t_{off} - 9 15 nsec

^d The Collector-to-Emitter Sustaining Voltage [$V_{CE(sus)}$] with the base open is that value of voltage which remains relatively constant over a wide range of collector currents, and approximates the collector voltage at which the effective alpha of the device is equal to unity ($V_{AM} = 1$; voltage at which the product of alpha (α), at low voltage, times the multiplication factor (M) equals unity).

^e See accompanying *Storage-Time-Measurement Circuit*.

^f See accompanying *Turn-On-Time and Turn-Off-Time Measurement Circuit*.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

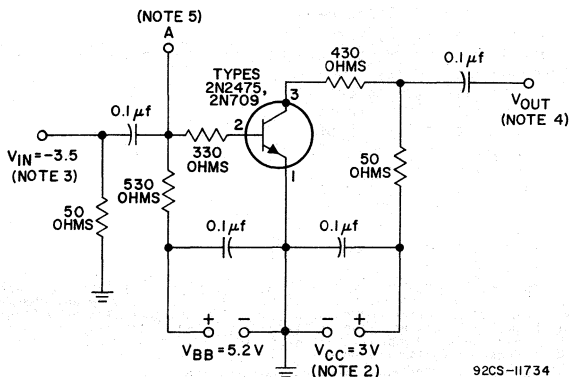
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



2N2475

STORAGE-TIME MEASUREMENT CIRCUIT



NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25- μ f DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB} .

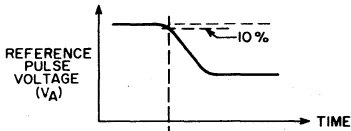
NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME < 1 NSEC; PULSE DURATION > 300 NSEC; AND DUTY FACTOR < 0.02 .

NOTE 4: INPUT AND OUTPUT WAVE FORMS SHOWN SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 0.5 NSEC; INPUT CAPACITANCE OF PROBE ≤ 2.5 pf WITH SHUNT RESISTANCE > 1000 OHMS.

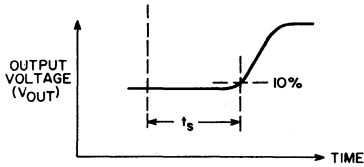
NOTE 5: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).



ASSOCIATED WAVE FORMS



REFERENCE WAVE FORM OBSERVED AT POINT "A" IN
STORAGE-TIME MEASUREMENT CIRCUIT



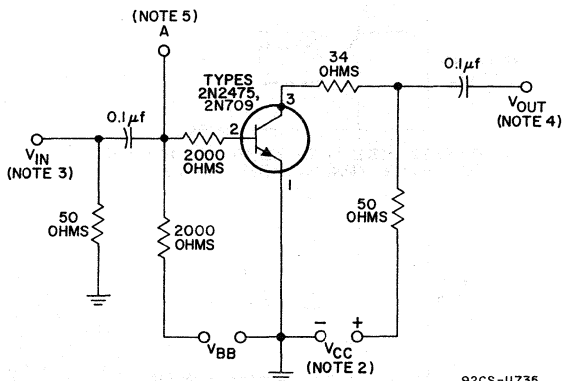
OUTPUT WAVE FORM

92CS-11728RI



2N2475

TURN-ON-TIME AND TURN-OFF-TIME MEASUREMENT CIRCUIT



92CS-11735

2N2475

2N709

t_{on}	t_{off}	t_{on}	t_{off}
V_{BB} : -1 volt	V_{BB} : +5 volts	V_{BB} : -1 volt	V_{BB} : +5 volts
V_{IN} : +4 volts	V_{IN} : -4 volts	V_{IN} : +6 volts	V_{IN} : -4 volts
V_{CC} : +1.8 volts	V_{CC} : +1.8 volts	V_{CC} : +1 volt	V_{CC} : +1 volt

NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25- μ f DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB} .

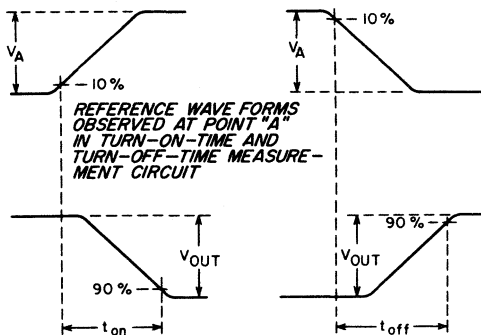
NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME < 1 NSEC; PULSE DURATION > 300 NSEC; AND DUTY FACTOR < 0.02 .

NOTE 4: INPUT AND OUTPUT WAVE FORMS SHOWN SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 0.5 NSEC; INPUT CAPACITANCE OF PROBE ≤ 2.5 pf WITH SHUNT RESISTANCE > 1000 OHMS.

NOTE 5: TEST POINT FOR OBSERVATION OF REFERENCE PULSE VOLTAGE (V_A).



ASSOCIATED WAVE FORMS



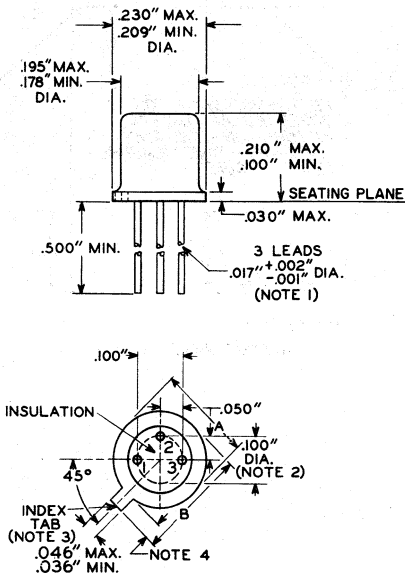
REFERENCE WAVE FORMS
OBSERVED AT POINT "A"
IN TURN-ON-TIME AND
TURN-OFF-TIME MEASURE-
MENT CIRCUIT

OUTPUT WAVE FORMS

92CS-11729R1



SIMILAR TO JEDEC No. TO-18



92CS-11739

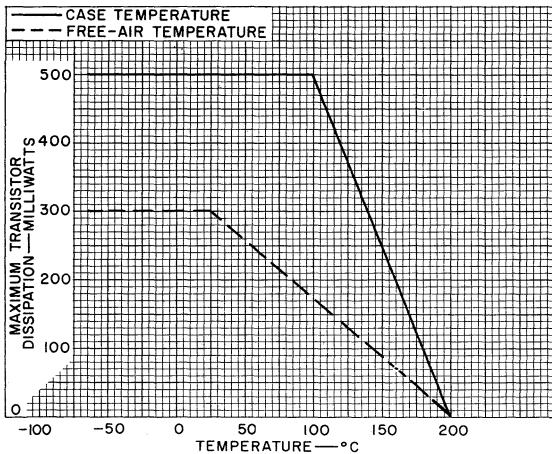
NOTE 1: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN 0.05" AND 0.25" FROM THE SEATING PLANE. BETWEEN 0.25" TO THE END OF THE LEAD, A MAXIMUM DIAMETER OF 0.021" IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIAMETER IS NOT CONTROLLED.

NOTE 2: MAXIMUM DIAMETER LEADS AT A GAUGING PLANE 0.054" + 0.001" - 0.000" BELOW SEATING PLANE TO BE WITHIN 0.007" OF THEIR TRUE LOCATION RELATIVE TO MAXIMUM WIDTH TAB AND TO THE MAXIMUM 0.230" DIAMETER MEASURED WITH A SUITABLE GAUGE. WHEN GAUGE IS USED, MEASUREMENT WILL BE MADE AT SEATING PLANE.

NOTE 3: FOR VISUAL ORIENTATION ONLY.

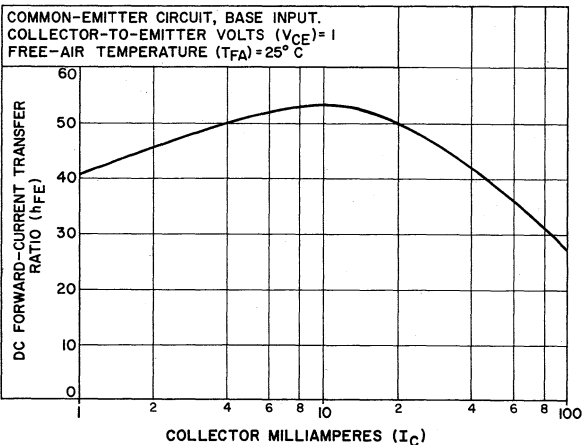
NOTE 4: TAB LENGTH TO BE 0.028" MINIMUM AND 0.048" MAXIMUM, AND WILL BE DETERMINED BY SUBTRACTING DIAMETER "A" FROM DIMENSION "B".

RATING CHART



92CS-11733RI

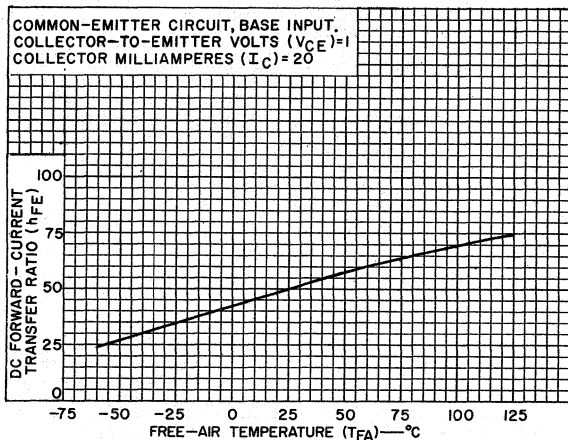
TYPICAL DC FORWARD-CURRENT-TRANSFER-RATIO CHARACTERISTIC



92CS-1173I

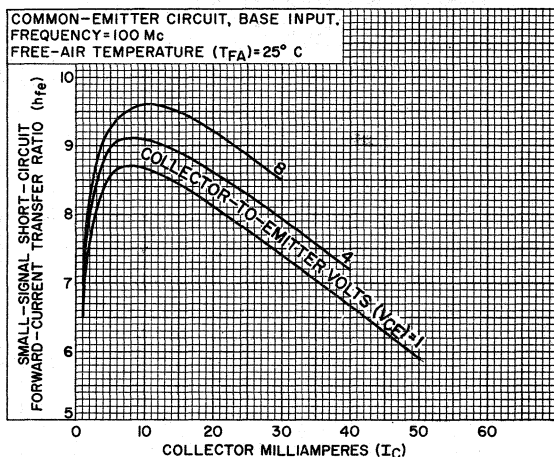


TYPICAL DC FORWARD-CURRENT-TRANSFER-RATIO CHARACTERISTIC



92CS-11724

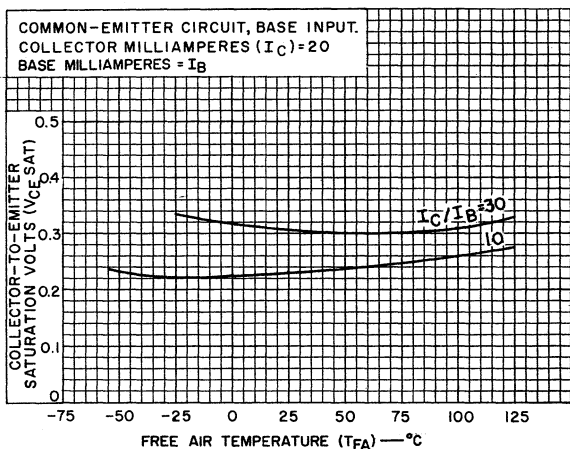
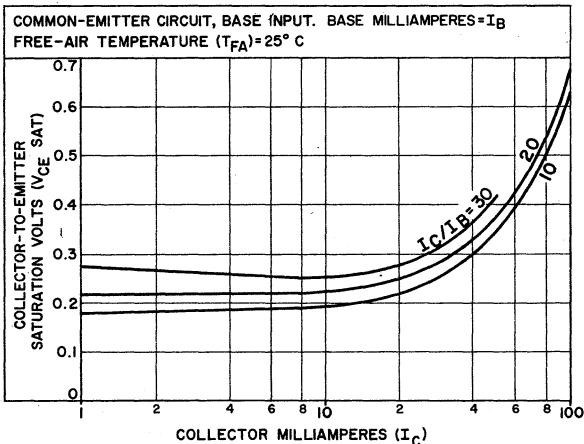
TYPICAL SMALL-SIGNAL SHORT-CIRCUIT FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



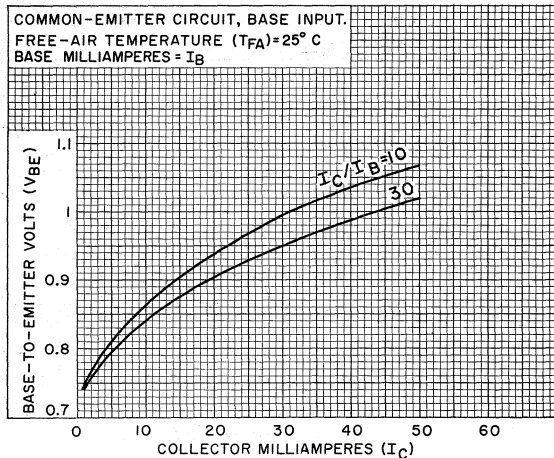
92CS-11725



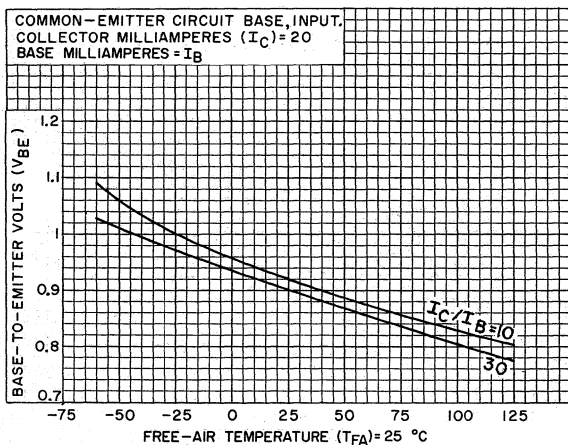
TYPICAL COLLECTOR-TO-EMITTER SATURATION-VOLTAGE CHARACTERISTICS



TYPICAL BASE-TO-EMITTER VOLTAGE CHARACTERISTICS



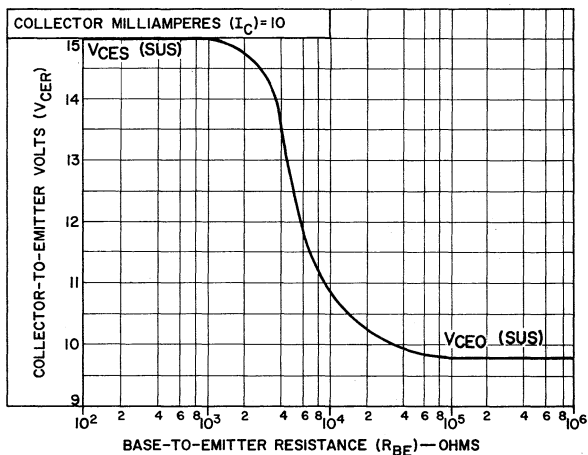
92CS-11727



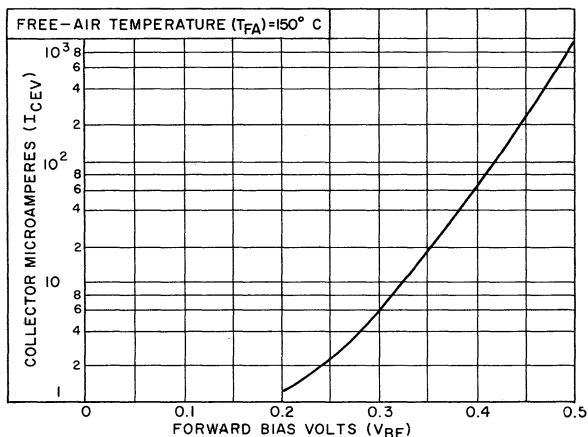
92CS-11726



TYPICAL COLLECTOR-TO-EMITTER VOLTAGE CHARACTERISTICS

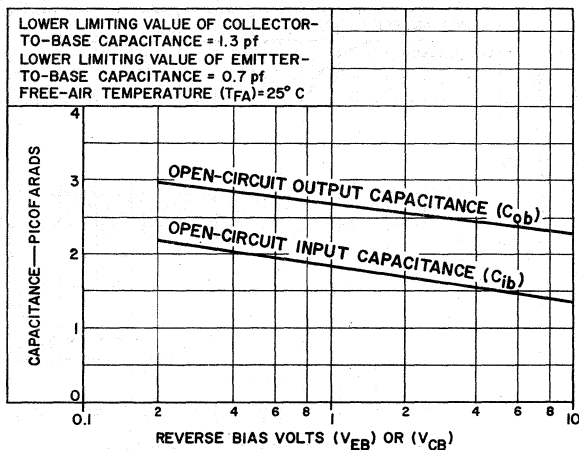


TYPICAL COLLECTOR-CURRENT CHARACTERISTIC



2N2475

TYPICAL INPUT- AND OUTPUT- CAPACITANCE CHARACTERISTICS



Transistor

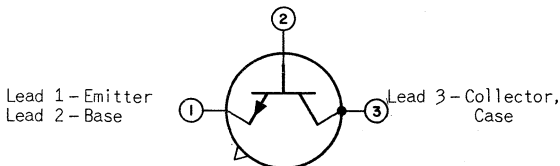
SILICON N-P-N DOUBLE-DIFFUSED-JUNCTION EPITAXIAL-PLANAR TYPE
For High-Speed, High-Current Switching in Core-Driving
and Line-Driving Applications in Data-Processing Systems

GENERAL DATA

Mechanical:

Dimensions. See Outline T0-5 in General Section

Terminal Diagram: BOTTOM VIEW



SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} 60 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With base open. V_{CEO} 20 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EB0} 5 max. volts

COLLECTOR CURRENT I_C Limited by power dissipation

TRANSISTOR DISSIPATION:^a P

At case temperature^b of
 25° C or below. 2 max. watts

At free-air temperature of
 25° C or below. 0.6 max. watt

TEMPERATURE RANGE:

Junction (Operating). T_J -65 to +200 °C

Storage T_{STG} -65 to +300 °C

LEAD TEMPERATURE:^c

For 10 seconds maximum. T_L 235 max. °C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, free-air temperature = 25° C

Min. Max.

DC Collector-to-Base Breakdown

Voltage for dc collector μa

= 10, emitter current = 0 . . . BV_{CBO} 60 - volts

^a See accompanying Rating Chart.

^b Measured at center of seating plane.

^c Measured 1/16" $\pm$ 1/32" along lead down from seating plane.



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 Semiconductor & Materials Division Somerville, N. J.

DATA 1
 8-62

2N2476

		Min.	Max.	
DC Collector-to-Emitter Breakdown Voltage for pulse dc collector ma. = 50 ^d , base current = 0	BV_{CEO}	20	-	volts
DC Emitter-to-Base Breakdown Voltage for dc emitter ma. = 0.1, collector current = 0	BV_{EBO}	5	-	volts
DC Base-to-Emitter Voltage for dc collector ma. = 150, dc base ma. = 7.5	V_{BE}	-	1	volt
DC Collector-to-Emitter Saturation Voltage: With dc collector ma. = 150, dc base ma. = 7.5	$V_{CE(sat)}$	-	0.4	volt
With dc collector ma. = 500, dc base ma. = 50		-	0.75	volt
DC Collector-Cutoff Current for dc collector-to-base volts = 30, emitter current = 0, free-air temperature = 25° C	I_{CBO}	-	0.2	μ a
150° C		-	200	μ a
DC Emitter-Cutoff Current for dc emitter-to-base volts = 5, collector current = 0	I_{EBO}	-	100	μ a
Output Capacitance for dc collector-to-base volts = 10, emitter current = 0, frequency (kc) = 140.	C_{ob}	-	10	pf
DC Forward-Current Transfer Ratio for dc collector-to-emitter volts = 0.4, dc collector ma. = 150.	h_{FE}	20	-	
Small-Signal Short-Circuit Forward-Current Transfer Ratio for dc collector-to-emitter volts = 10, dc collector ma. = 50, frequency (Mc) = 100. . .	h_{fe}	2.5	-	
Switching Time: Storage time ^e for dc collector supply volts = 6.4, collector resistance (ohms) = 40, turn-on dc base ma. = 15, turn-off dc base ma. = -15, dc collector ma. = 150	t_s	-	25	nsec
Turn-on time ^f (Delay time + rise time) for dc collector supply volts = 6.4, turn-on dc base ma. = 15, dc collector ma. = 150	t_{on}	-	25	nsec
Turn-off time ^e (Storage time + fall time) for dc collector supply volts = 6.4, turn-on dc base ma. = 15, turn-off dc base ma. = -15, dc collector ma. = 150	t_{off}	-	45	nsec



- d Pulse duration $\leq 400 \mu\text{sec}$, duty factor = 0.03.
 e See accompanying *Storage-Time and Turn-Off-Time Measurement Circuit*.
 f See accompanying *Turn-On-Time Measurement Circuit*.

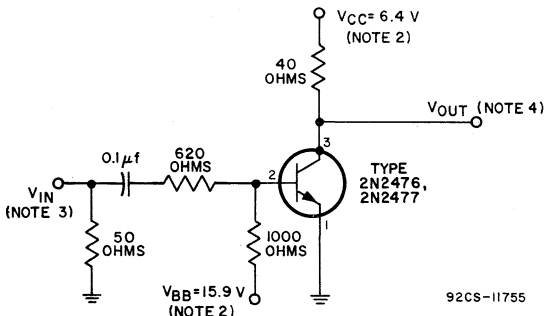
OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

STORAGE-TIME AND TURN-OFF-TIME MEASUREMENT CIRCUIT



NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PERCENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT $25\text{-}\mu\text{f}$ DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB} .

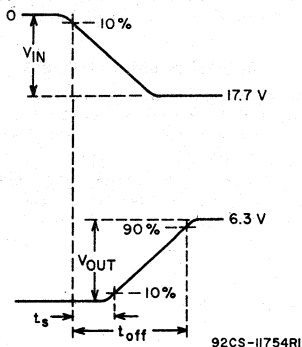
NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME < 2 NANOSECONDS; PULSE DURATION > 150 NANOSECONDS; DUTY FACTOR < 0.02 .

NOTE 4: THE ASSOCIATED INPUT AND OUTPUT WAVE FORMS SHOWN SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 0.5 NANOSECOND; INPUT CAPACITANCE OF PROBE < 2.5 PICO FARADS WITH SHUNT RESISTANCE OF 1 MEGOHM.

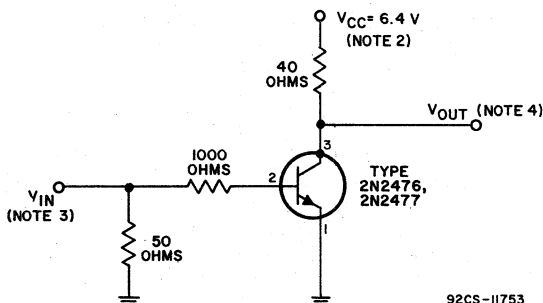


2N2476

ASSOCIATED WAVE FORMS



TURN-ON-TIME MEASUREMENT CIRCUIT



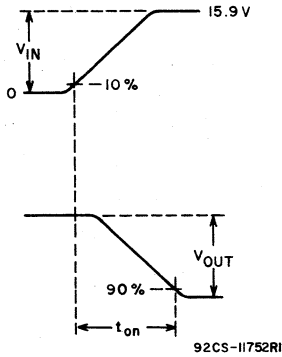
NOTE 1: ALL RESISTANCE VALUES HAVE ± 1 PER CENT TOLERANCE.

NOTE 2: WITH CERTAIN TYPES OF POWER SUPPLIES, IT MAY BE NECESSARY TO CONNECT 25- μf DECOUPLING CAPACITORS ACROSS THE POWER-SUPPLY TERMINALS FOR V_{CC} AND V_{BB} .

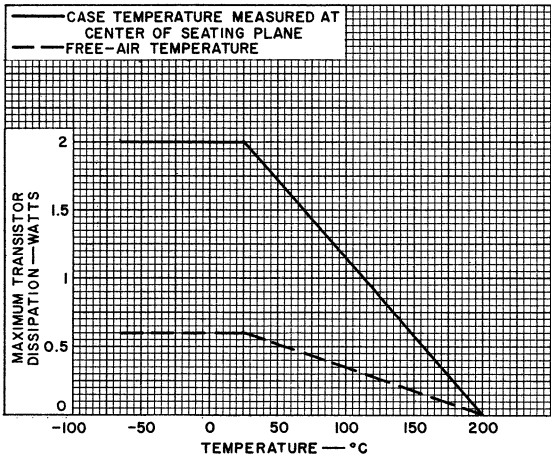
NOTE 3: INPUT VOLTAGE (V_{IN}) OBTAINED FROM MERCURY-RELAY TYPE PULSE GENERATOR HAVING AN OUTPUT IMPEDANCE OF 50 OHMS. V_{IN} RISE TIME < 2 NANoseconds; PULSE DURATION > 150 NANoseconds AND DUTY FACTOR < 0.02 .

NOTE 4: THE ASSOCIATED INPUT AND OUTPUT WAVE FORMS SHOWN SHOULD BE MONITORED BY MEANS OF A SAMPLING OSCILLOSCOPE HAVING A RISE TIME < 0.5 NANoseconds; INPUT CAPACITANCE OF PROBE < 2.5 PICO FARADS WITH SHUNT RESISTANCE OF 1 MEGOHM.

ASSOCIATED WAVE FORMS



RATING CHART



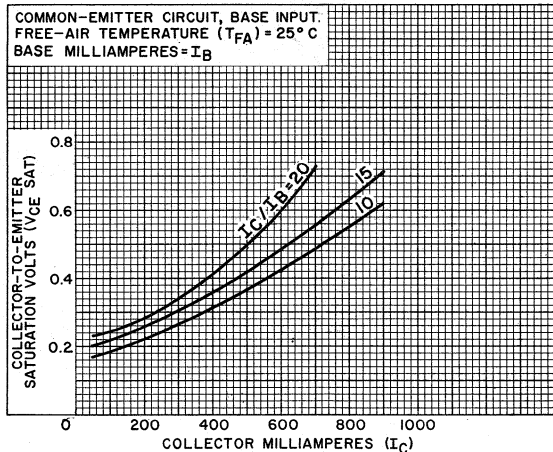
92CS-11751RI



RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

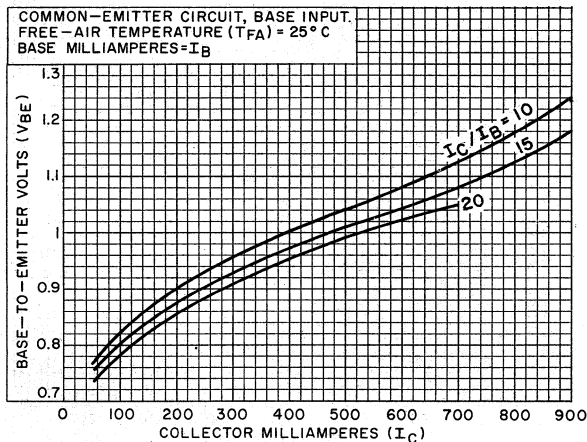
DATA 3
8-62

TYPICAL COLLECTOR-TO-EMITTER SATURATION-VOLTAGE CHARACTERISTICS



92CS-11768

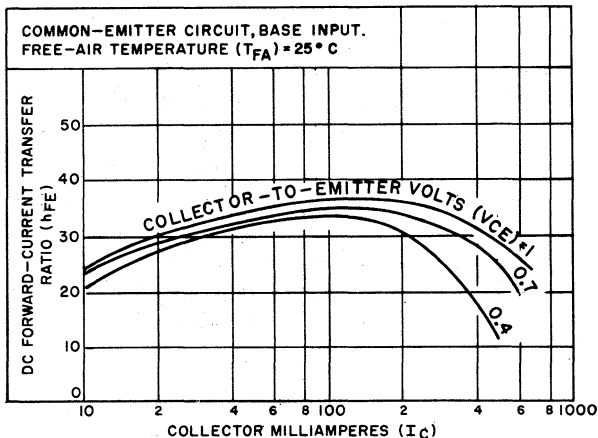
TYPICAL BASE-TO-EMITTER VOLTAGE CHARACTERISTICS



92CS-11767

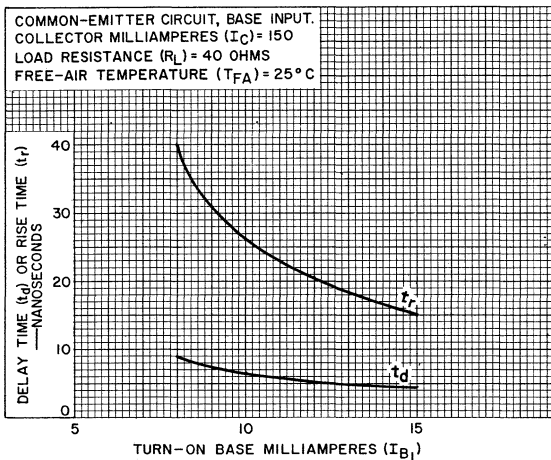


TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



92CS-11761

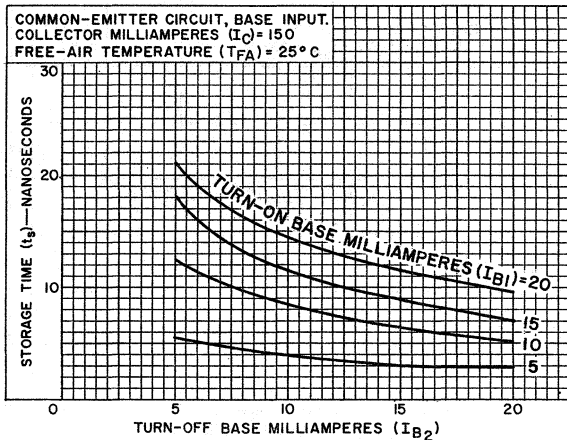
TYPICAL DELAY-TIME AND RISE-TIME CHARACTERISTICS



92CS-11762



TYPICAL STORAGE-TIME CHARACTERISTICS



92CS-11769



Transistor

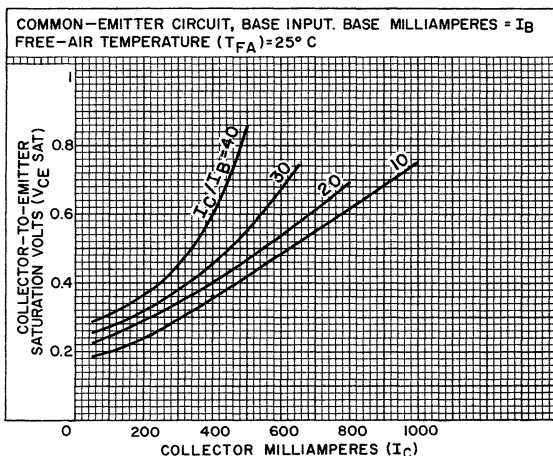
SILICON N-P-N DOUBLE-DIFFUSED-JUNCTION EPITAXIAL-PLANAR TYPE

For High-Speed, High-Current Switching in Core-Driving
and Line-Driving Applications in Data-Processing Systems

The 2N2477 is the same as the 2N2476 except for the following items:

ELECTRICAL CHARACTERISTICS

		Min.	Max.	
DC Base-to-Emitter Voltage for dc collector ma. = 150, dc base ma. = 3.75	V_{BE}	-	0.95	volt
DC Collector-to-Emitter Saturation Voltage: With dc collector ma. = 150, dc base ma. = 3.75	$V_{CE(sat)}$	-	0.4	volt
With dc collector ma. = 500, dc base ma. = 50		-	0.65	volt
DC Forward-Current Transfer Ratio for dc collector-to- emitter volts = 0.4, dc collector ma. = 150	h_{FE}	40	-	

TYPICAL COLLECTOR-TO-EMITTER SATURATION-
VOLTAGE CHARACTERISTICS

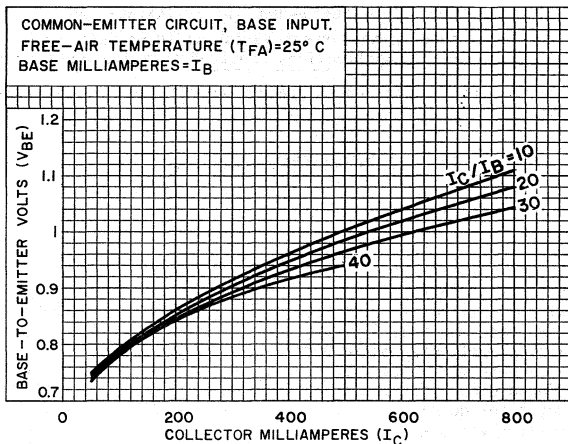
92CS-11758



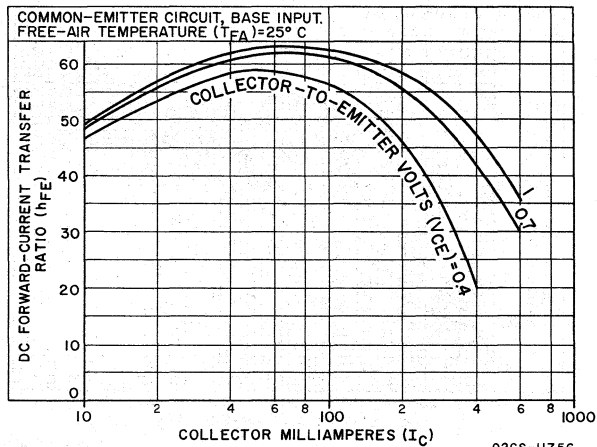
RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

DATA 1
8-62

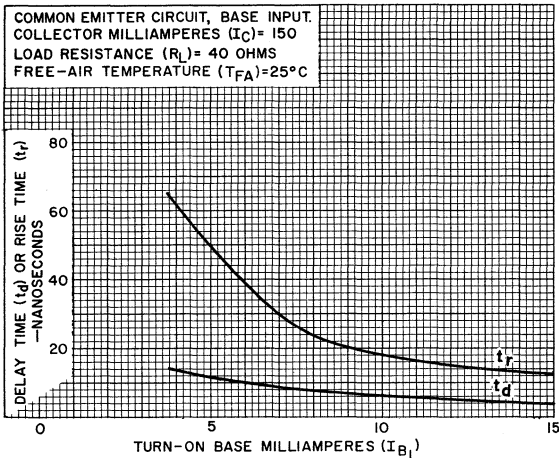
TYPICAL BASE-TO-EMITTER VOLTAGE CHARACTERISTICS



TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS

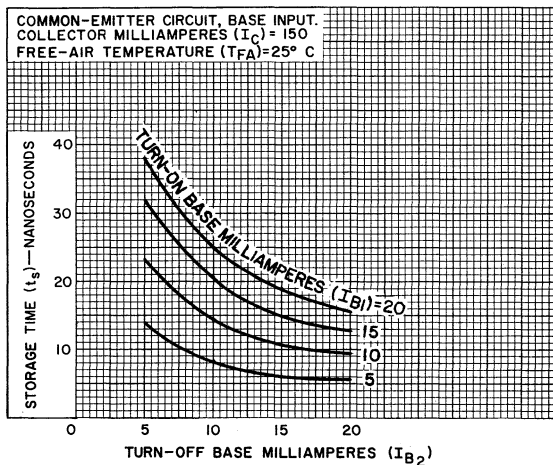


TYPICAL DELAY-TIME AND RISE-TIME CHARACTERISTICS



92CS-11760

TYPICAL STORAGE-TIME CHARACTERISTICS



92CS-11757



Transistor

GERMANIUM P-N-P ALLOY TYPE

For Small-Signal Low-Noise AF Amplifier Applications in Consumer-Product and Industrial Equipment

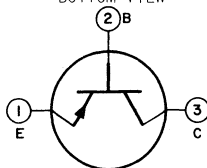
Mechanical:

Dimensions. See Outline TO-1 in General Section

Terminal Diagram

BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector

Maximum and Minimum Ratings, Absolute-Maximum Values: ←

Collector-to-Base Voltage. V_{CBO} -30 max. volts
With emitter open

Collector-to-Emitter Voltage. V_{CER} -25 max. volts
With external base-to-emitter resistance = 10000 ohms

Emitter-to-Base Voltage. V_{EBO} -25 max. volt
With collector open

Collector Current. I_C -50 max. ma

Emitter Current. I_E 50 max. ma

Transistor Dissipation

At free-air temperatures:

From -65° to 55° C. P_T 120 max. mw

Above 55° C. Derate linearly 2.6 mw/ $^{\circ}$ C

Temperature

Operating range (Junction)^a. T_{opr} -65 to 100 $^{\circ}$ C

Storage range. T_{stg} -65 to 100 $^{\circ}$ C

Leads^b (During soldering):

For 10 seconds maximum. T_L 255 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS ←

Free-air temperature = 25° C

Min. Typ. Max.

DC Collector-to-Base Breakdown Voltage. BV_{CBV} -30 - - volts
 $V_{EB} = -2$ volts,
 $I_C = -0.05$ ma.

DC Collector-to-Emitter Breakdown Voltage. BV_{CER} -25 - - volts
 $R_{BE} = 10000$ ohms,
 $I_C = -1$ ma.

← Indicates a change.



	Min.	Typ.	Max.	
DC Emitter-to-Base Break-down Voltage.	BV_{EBO}	-25	-	volts
$I_E = -0.05$ ma., $I_C = 0$				
DC Collector-Cutoff Current	I_{CBO}	-	-5	μ a
$V_{CB} = -20$ volts, $I_E = 0$				
DC Emitter-Cutoff Current	I_{EBO}	-	-7.5	μ a
$V_{EB} = -20$ volts, $I_C = 0$				
Extrinsic Base-Lead Resistance.	$r_{bb'}$	-	300	ohms
$f = 20$ Mc, $V_{CE} = -4.5$ volts, $I_C = -0.5$ ma.				
Collector-to-Base Feedback Capacitance.	$C_{b'c}$	-	10	pf
$V_{CE} = -4.5$ volts, $I_C = -0.5$ ma.				
Small-Signal Short-Circuit Forward-Current Transfer Ratio	h_{fe}	120	200	-
$f = 1$ kc, $V_{CE} = -4$ volts, $I_C = -0.5$ ma.				
Small-Signal Short-Circuit Forward-Current Transfer Ratio Cutoff Frequency.	f_{hfb}	-	10	Mc
$V_{CE} = -4.5$ volts, $I_C = -0.5$ ma.				
RMS Noise Input Current (Equivalent).	i_N	-	-	0.001^c μ a
frequency range = 20 to 20000 cps, $V_{CE} = -4.5$ volts, $I_C = -0.5$ ma., $R_{BE} = 5000$ ohms				
Noise Figure.	N_F	-	-	4^c db
Circuit Bandwidth = 1.1 kc, $f = 1$ kc, $V_{CE} = -4.5$ volts, $I_C = -0.5$ ma., $R_G = 1000$ ohms				

^a See *Operating Considerations*.

^b Measured along lead at distances equal to or greater than 1/32" from seating plane.

^c If the device is operated at free-air temperatures above 25° C, the maximum value for this characteristic may be higher than that shown.

OPERATING CONSIDERATIONS

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

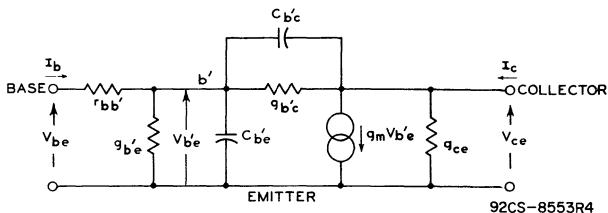
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat



of the soldering operation may crack the seals of the leads and damage the transistor.

To assure excellent noise performance, the junction temperature for this device should be kept as low as possible.

"HYBRID π " EQUIVALENT CIRCUIT



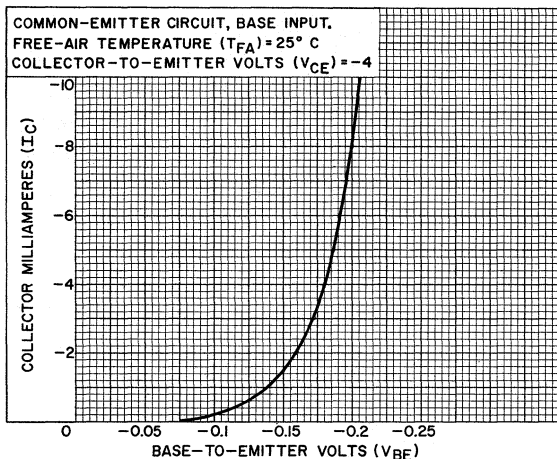
V_{ce} : -4.5 volts	g_{ce} : 5 μ hos
I_C : -0.5 ma	$C_{b'e}$: 300 pf
$r_{bb'}$: 300 ohms	$C_{b'c}$: 10 pf
$g_{b'e}$: 95 μ hos	g_m : 19200 μ hos
$g_{b'c}$: 0.4 μ ho	

NOTE: The Approximate Frequency F for Unity Power Amplification Based on this Equivalent Circuit is Given by:

$$f = \frac{1}{4\pi} \sqrt{\frac{g_m}{r_{bb'} C_{b'c} C_{b'e}}}$$

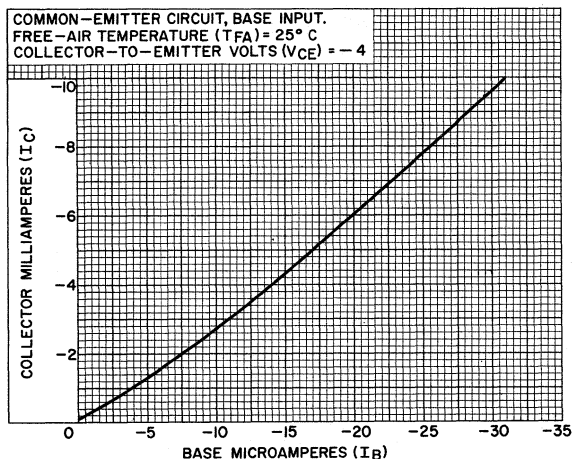


TYPICAL TRANSFER CHARACTERISTIC



92CS-11842R1

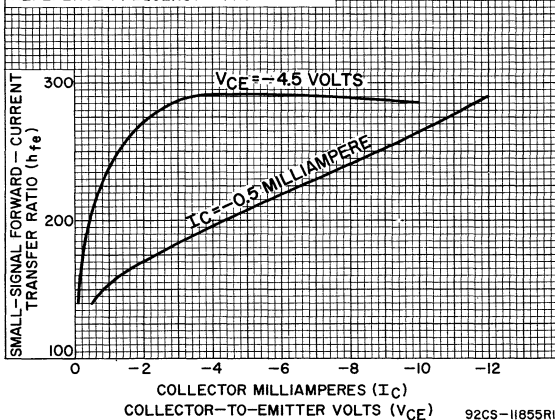
TYPICAL CURRENT-TRANSFER CHARACTERISTIC



92CS-12090

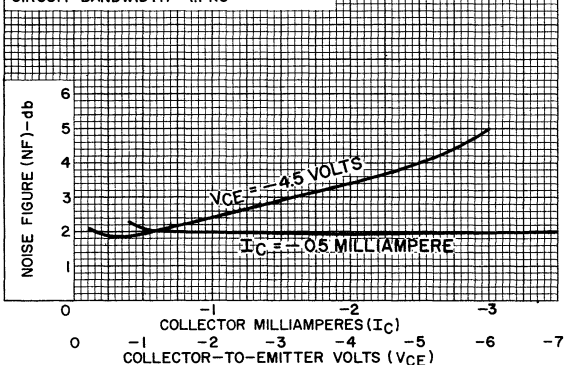
TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER RATIO CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
 FREE-AIR TEMPERATURE (T_{FA}) = 25° C
 REFERENCE FREQUENCY = 1 Kc



TYPICAL NOISE CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
 FREE-AIR TEMPERATURE (T_{FA}) = 25° C
 REFERENCE FREQUENCY = 1 Kc
 GENERATOR RESISTANCE = 1000 OHMS
 CIRCUIT BANDWIDTH = 1.1 Kc



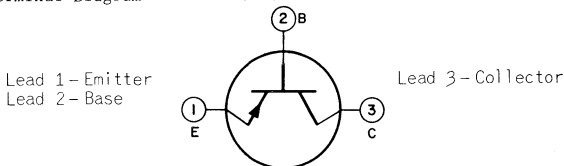
Transistor

GERMANIUM P-N-P ALLOY TYPE

For Small-Signal Low-Noise AF Amplifier Applications
in Consumer-Product and Industrial Equipment

Mechanical:

Dimensions See Outline TO-1 in General Section
Terminal Diagram BOTTOM VIEW



Maximum and Minimum Ratings, Absolute-Maximum Values: ←

Collector-to-Base Voltage.	V_{CBO}	-40 max.	volts
With emitter open			
Collector-to-Emitter Voltage	V_{CER}	-35 max.	volts
With external base-to-emitter resistance = 10000 ohms			
Emitter-to-Base Voltage.	V_{EBO}	-25 max.	volts
With collector open			
Collector Current.	I_C	-50 max.	ma
Emitter Current.	I_E	50 max.	ma

Transistor Dissipation

At free-air temperatures:

From -65° to 55° C	P_T	120 max.	mw
Above 55° C.	Derate linearly 2.6 mw/°C		

At case temperatures:

In infinite heat-sink—			
From -65° to 55° C	P_T	300 max.	mw
Above 55° C.	Derate linearly 6.67 mw/°C		

In practical heat-sink, thermal
resistance = 50° C/watt—

From -65° to 55° C	P_T	255 max.	mw
Above 55° C.	Derate linearly 5 mw/°C		

Temperature

Operating range (Junction) ^a	T_{opr}	-65 to 100	°C
Storage range.	T_{stg}	-65 to 100	°C
Leads ^b (During soldering):			
For 10 seconds maximum	T_L	255 max.	°C

← Indicates a change.



ELECTRICAL CHARACTERISTICS

Free-air temperature = 25° C

Min. Typ. Max.

DC Collector-to-Base				
Breakdown Voltage.	BV_{CBV}	-40	-	volts
$V_{EB} = -2$ volts, $I_C = -0.05$ ma.				
DC Collector-to-Emitter				
Breakdown Voltage.	BV_{CER}	-35	-	volts
$R_{BE} = 10000$ ohms, $I_C = -1$ ma.				
DC Emitter-to-Base				
Breakdown Voltage.	BV_{EBO}	-25	-	volts
$I_E = -0.05$ ma., $I_C = 0$				
DC Collector-Cutoff Current.	I_{CBO}	-	-	-5 μ a
$V_{CB} = -20$ volts, $I_E = 0$				
DC Emitter-Cutoff Current.	I_{EBO}	-	-	-7.5 μ a
$V_{EB} = -20$ volts, $I_C = 0$				
Extrinsic Base-Lead				
Resistance	$r_{bb'}$	-	300	ohms
$f = 20$ Mc, $V_{CE} = -6$ volts, $I_C = -1$ ma.				
Collector-to-Base Feedback				
Capacitance.	$C_{b'c}$	-	9	pf
$V_{CE} = -6$ volts, $I_C = -1$ ma.				
Small-Signal Short-Circuit				
Forward-Current Transfer				
Ratio.	h_{fe}	100	160	-
$f = 1$ kc, $V_{CE} = -6$ volts, $I_C = -1$ ma.				
Small-Signal Short-Circuit				
Forward-Current Transfer				
Ratio Cutoff Frequency	f_{hfb}	-	10	Mc
$V_{CE} = -6$ volts, $I_C = -1$ ma.				

^a See *Operating Considerations*.

^b Measured along lead at distances equal to or greater than 1/32" from seating plane.

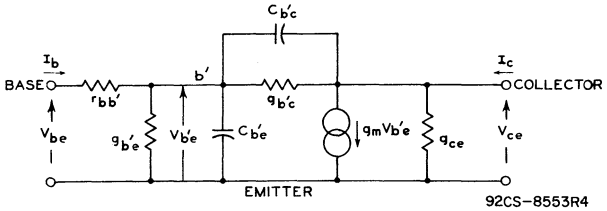
OPERATING CONSIDERATIONS

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.



"HYBRID π " EQUIVALENT CIRCUIT



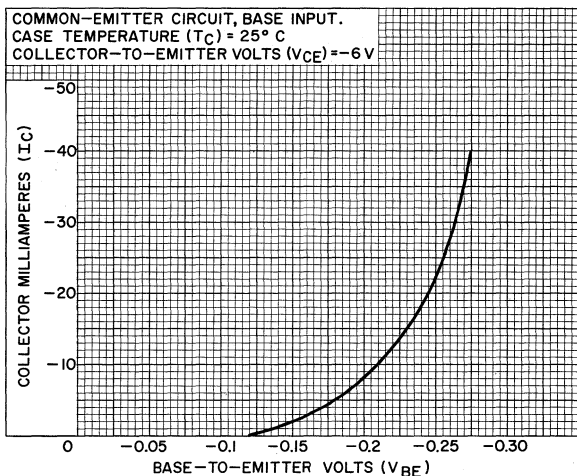
V_{ce} : -6 volts	g_{ce} : 6 μ hos
I_c : -1 ma	$C_{b'e}$: 750 pf
$r_{bb'}$: 300 ohms	$C_{b'c}$: 9 pf
$g_{b'e}$: 250 μ hos	g_m : 38500 μ hos
$g_{b'c}$: 0.35 μ ho	

NOTE: The approximate frequency F for unity power amplification based on this equivalent circuit is given by:

$$f = \frac{1}{4\pi} \sqrt{\frac{g_m}{r_{bb'} C_{b'c} C_{b'e}}}$$

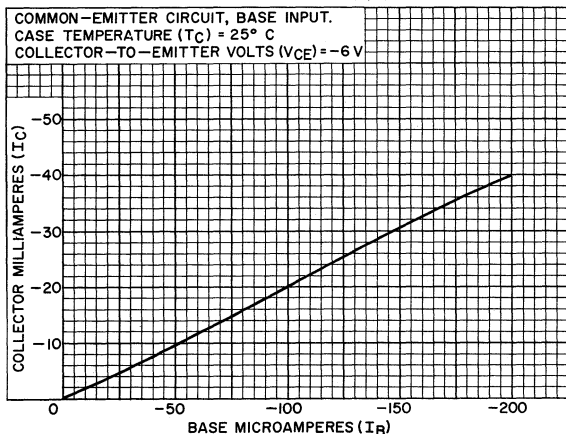


TYPICAL TRANSFER CHARACTERISTIC



92CS-11843RI

TYPICAL CURRENT-TRANSFER CHARACTERISTIC

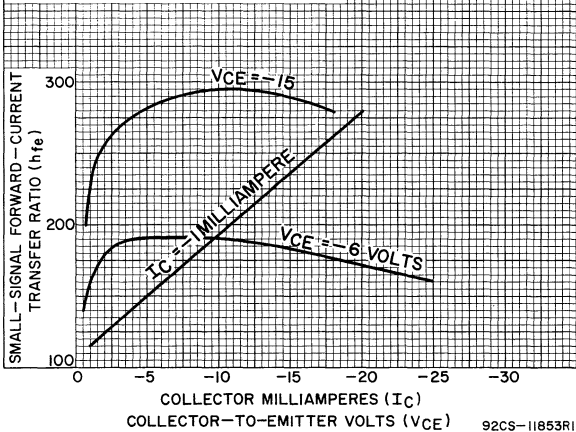


92CS-11851RI

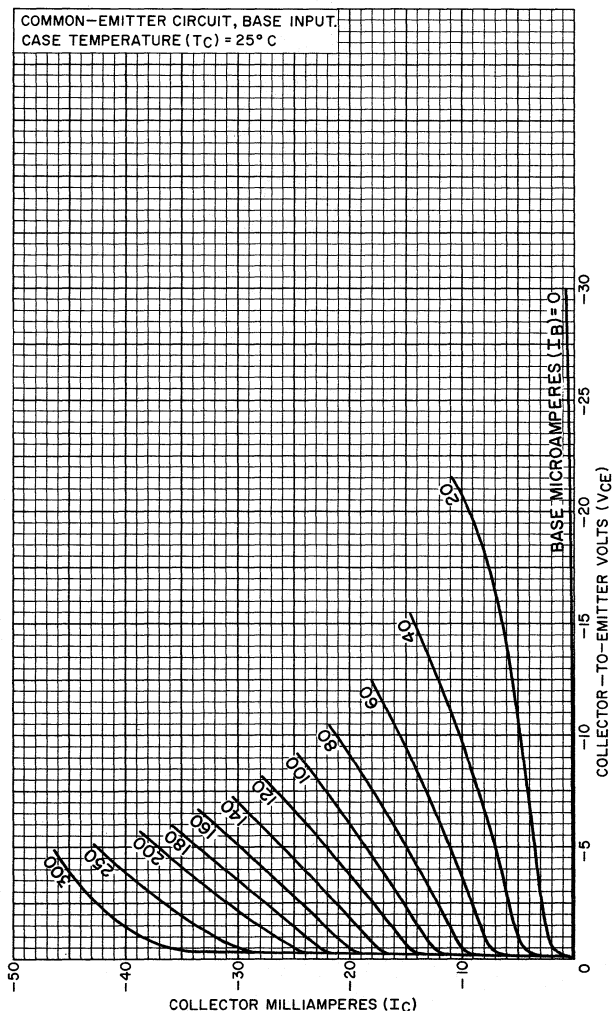


TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
CASE TEMPERATURE (T_C) = 25° C
REFERENCE FREQUENCY = 1 Kc



TYPICAL COLLECTOR CHARACTERISTICS



92CM-11836R1



Transistor

SILICON N-P-N TRIPLE-DIFFUSED-JUNCTION PLANAR TYPE

For Large-Signal, High-Power VHF Applications in Industrial and Military Communications Equipment

The 2N2631 is the same as the 2N2876 except for the following items:

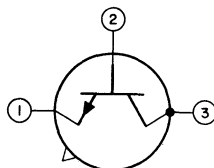
GENERAL DATA

Mechanical:

Dimensions. Similar to TO-5 outline except this type has a minimum lead length of 0.5 inch (See Outline TO-5 in General Section)

Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

RADIO-FREQUENCY SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR CURRENT I_C 1.5 max. amp

TRANSISTOR DISSIPATION: P_T

At case temperatures:^a

From -65° to 25° C. 8.75 max. watts

Above 25° C. Derate linearly 0.05 watt/°C

TEMPERATURE:

Lead:^b

For 10 seconds maximum. . . T_L 230 max. °C

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C

Min. Typ. Max.

DC Collector-to-Emitter

Saturation Voltage for

dc collector amperes

= 1.5, dc base

amperes = 0.3 $V_{CE(sat)}$ - - 1 volt

Collector-to-Case

Capacitance shown for

type 2N2876 Not applicable to this type



RADIO CORPORATION OF AMERICA
Electronic Components and Devices Harrison, N. J.

DATA 1
8-63

Min. Typ. Max.

RF Power Output,
Unneutralized:^d

With dc collector-to-
emitter volts = 28, dc
collector ma. = 375,
rf power input (watts)
= 1, frequency (Mc)

= 50 P_o 7.5 - - watts

With dc collector-to-
emitter volts = 28, dc
collector ma. = 275,
rf power input (watts)
= 1, frequency (Mc)

= 150. P_o 3 - - watts

^a Measured at center of seating plane.

^b Measured along lead at distance not less than 1/32" from seating plane.

^d See accompanying Power-Output-Measurement Circuit. Q = Transistor type 2N2631.

NOTE: Collector lead of type 2N2631 is connected to case.

OPERATING CONSIDERATIONS

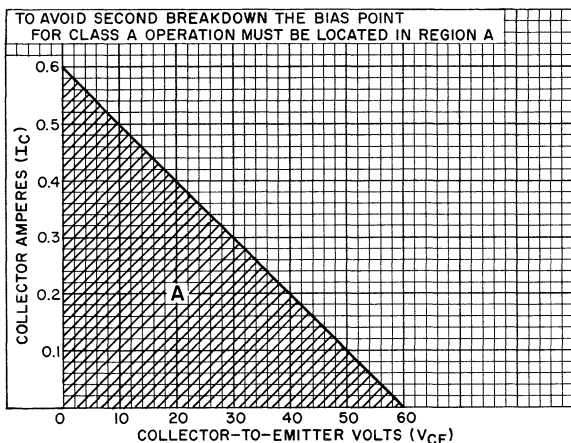
This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

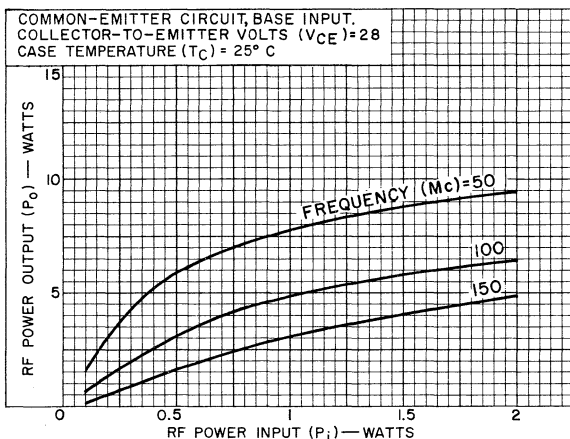


REGION OF SAFE OPERATION Without Second Breakdown in Class A Service



92CS-12039

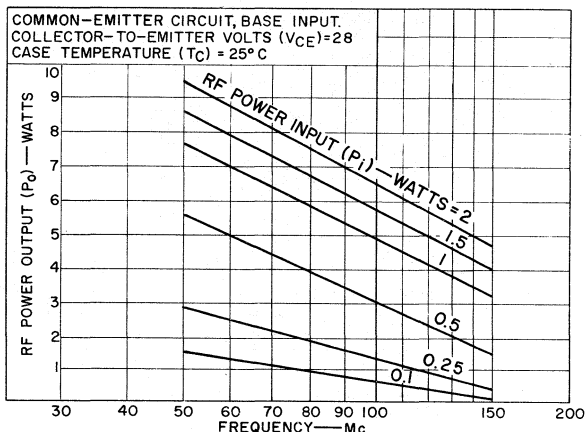
TYPICAL OPERATION CHARACTERISTICS



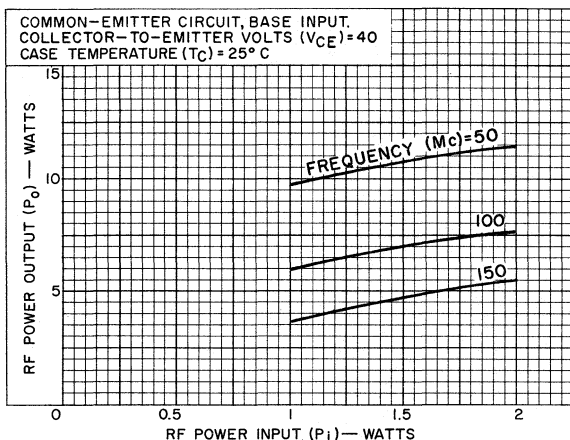
92CS-12049RI



TYPICAL OPERATION CHARACTERISTICS



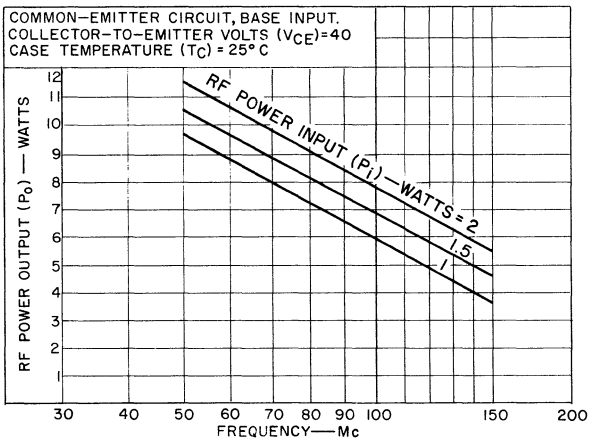
92CS-12046RI



92CS-12048RI



TYPICAL OPERATION CHARACTERISTICS



92CS-12047R1



Transistor

SILICON N-P-N DOUBLE-DIFFUSED EPITAXIAL-PLANAR TYPE

For Amplifier, Mixer, and Oscillator Service
in VHF and UHF (200 to 500 Mc) Applications

GENERAL DATA

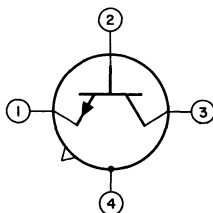
Mechanical:

Dimensions. Similar to T0-18 outline except this device has 4 leads

(See Outline T0-18 in General Section)
BOTTOM VIEW

Terminal Diagram:

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector
Lead 4 - Case

RADIO-FREQUENCY SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} 35 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With base open. V_{CEO} 20 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EB0} 3 max. volts

COLLECTOR CURRENT I_C Limited by power dissipation

TRANSISTOR DISSIPATION:

At free-air temperatures:

From -65° to 25° C. P_T 200 max. mw

Above 25° C. Derate linearly 1.14 mw/ $^{\circ}$ C

TEMPERATURE:

Junction (Operating). T_J -65 to 200 $^{\circ}$ C

Storage T_{STG} -65 to 200 $^{\circ}$ C

Leads^a, for 10 seconds maximum. T_L 230 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, free-air temperature = 25° C

Min. Typ. Max.

DC Collector-to-Base Breakdown

Voltage for dc collector μ a

= 1, emitter current = 0. . . BV_{CBO} 35 - - volts

^a Measured along lead at distances not less than 1/16" down from seating plane.



2N2708

		Min.	Typ.	Max.	
DC Collector-to-Emitter Breakdown Voltage for dc collector ma. = 3 ^b , base current = 0. . . .	$BV_{CEO(SUS)}$	20	-	-	volts
DC Emitter-to-Base Breakdown Voltage for dc emitter $\mu a = 10$, collector current = 0. . .	BV_{EBO}	3	-	-	volts
DC Collector-Cutoff Current for dc collector-to-base volts = 15, emitter current = 0, free-air temperature = 25° C	I_{CBO}	-	-	0.01	μa
150° C.		-	-	1	μa
Input Capacitance ^c for dc emitter-to-base volts = 0.5, collector current = 0, frequency (kc) = 140, lead 4 open. . . .	C_{ib}	-	1.4	-	pf
Output Capacitance ^c for dc collector-to-base volts = 15, emitter current = 0, frequency (kc) = 140, lead 4 open	C_{ob}	-	-	1.5	pf
Transconductance for dc collector-to-emitter volts = 15, dc collector ma. = 2, frequency (Mc) = 200.	g_m	-	25	-	mmho
DC Forward-Current Transfer Ratio for dc collector-to-emitter volts = 2, dc collector ma. = 2.	h_{FE}	30	-	200	
Small-Signal Short-Circuit Forward-Current Transfer Ratio for dc collector-to-emitter volts = 15, dc collector ma. = 2, frequency (kc) = 1.	h_{fe}	30	-	180	
Magnitude of Small-Signal Short-Circuit Forward-Current Transfer Ratio for dc collector-to-emitter volts = 15, dc collector ma. = 2, frequency (Mc) = 100 . . .	$ h_{fe} $	7	-	12	



	Min.	Typ.	Max.	
Collector-to-Base Time Constant for dc collector-to-base volts = 15, dc collector ma. = 2, frequency (Mc) = 31.9, lead 4 grounded.	$r_b' C_c$	15	-	33 psec
Small-Signal Common Emitter Power Gain for dc collector-to-emitter volts = 15, dc collector ma. = 2, frequency (Mc) = 200: Neutralized ^d , lead 4 grounded	G_{pe}	15	-	22 db
Unneutralized		-	12	- db
Noise Figure for dc collector-to-emitter volts = 15, dc collector ma. = 2, source resistance (ohms) = 50, frequency (Mc) = 200	NF	-	-	8.5 db

^b Pulse duration ≤ 300 μ seconds, duty factor ≤ 0.01 .

^c See accompanying *Relationship of Capacitances* drawing.

^d See accompanying *Neutralized Amplifier Circuit*.

OPERATING CONSIDERATIONS

It is recommended that this transistor not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

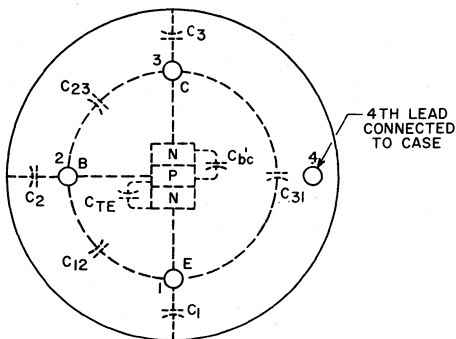
The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



RELATIONSHIP OF CAPACITANCES

C_{ob} , C_{ib} , $C_{b'c}$, and C_{TE}



92CS-11931

$C_1 C_2 C_3$: 0.9 (approx.) pf

C_{12} : 0.5 (approx.) pf

$C_{23} C_{31}$: 0.6 (approx.) pf

C_{ob} = capacitance between base and collector (with collector reverse biased and emitter open)

With case ungrounded:

$$C_{ob} = C_2 C_3 / (C_2 + C_3) + C_{23} + C_{bc}$$

Since $C_2 = C_3$,

$$C_{ob} = 0.9 \text{ pf} / 2 + 0.6 \text{ pf} + C_{bc}$$

$$= 1.05 \text{ pf} + C_{bc}$$

With case grounded:

$$C_{ob} = C_{23} + C_{bc} + C_3$$

C_{ib} = capacitance between base and emitter (with emitter reverse biased and collector open)

With case ungrounded:

$$C_{ib} = C_2 C_1 / (C_2 + C_1) + C_2 + C_{TE}$$

$$= 0.95 \text{ pf} + C_{TE}$$

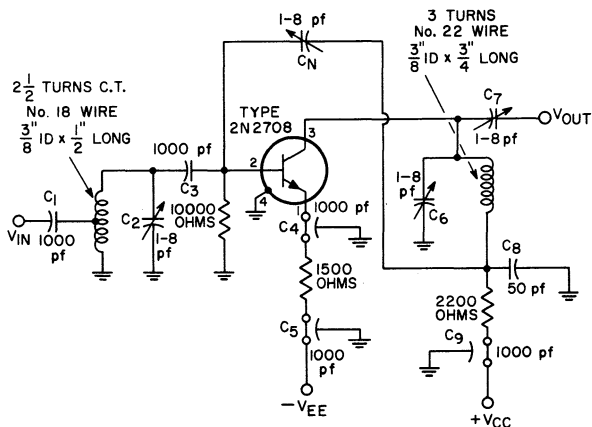
With case grounded:

$$C_{ib} = C_{12} + C_{TE} + C_2$$

C_{TE} = intrinsic base-to-emitter junction capacitance

C_{bc} = intrinsic base-to-collector junction capacitance

NEUTRALIZED AMPLIFIER CIRCUIT For Power Gain Measurement at 200 Mc



92CS-11930

NEUTRALIZATION PROCEDURE:

(a) Connect a 200-Mc signal generator (with $Z_{out} = 50$ ohms) to the input terminals of the amplifier. (b) Connect a 50-ohm r-f voltmeter across the output terminals of the amplifier. (c) Apply V_{EE} and V_{CC} , and with the signal generator adjusted for 10 mv output, tune C_2 , C_6 , and C_7 for maximum output. (d) Interchange the connections to the signal generator and the output indicator. (e) With sufficient signal applied to the output terminals of the amplifier, adjust C_N for a minimum indication at the input. (f) Repeat steps (a), (b), and (c) to determine if retuning is necessary.

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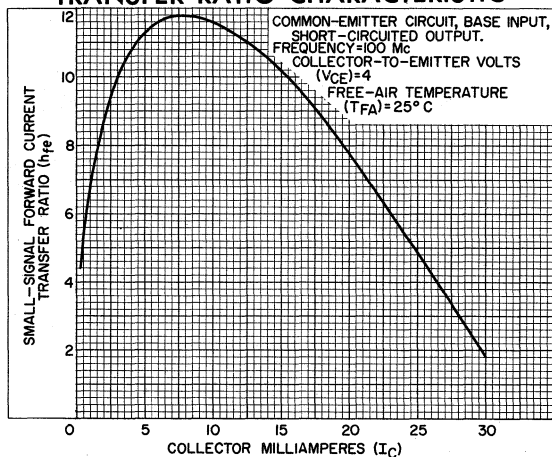
RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division

Somerville, N. J.

DATA 3

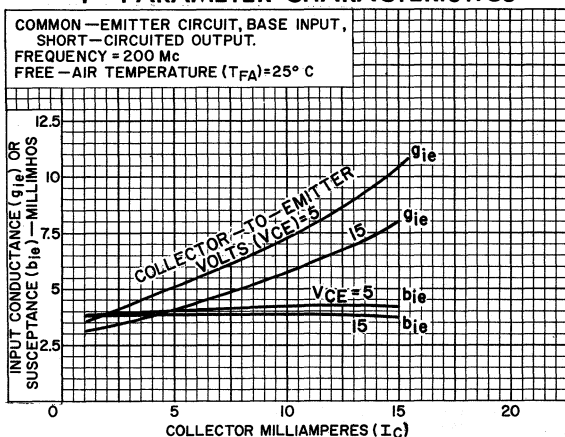
6-63

TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER RATIO CHARACTERISTIC



92CS-11940

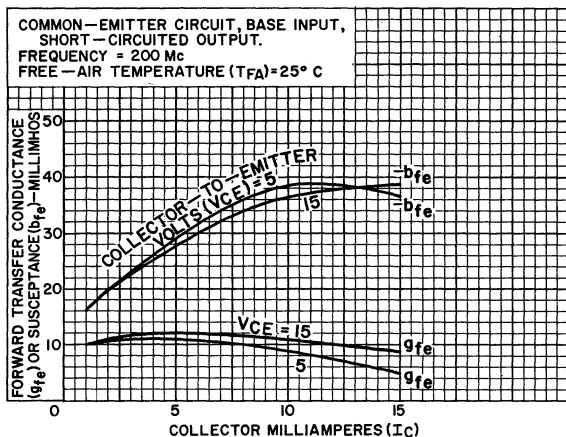
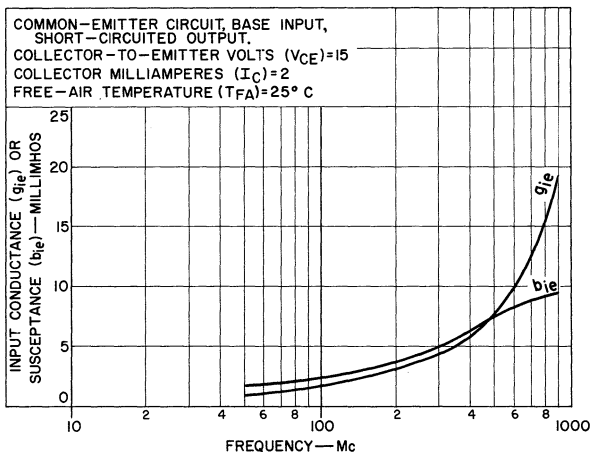
TYPICAL SMALL-SIGNAL "Y" PARAMETER CHARACTERISTICS



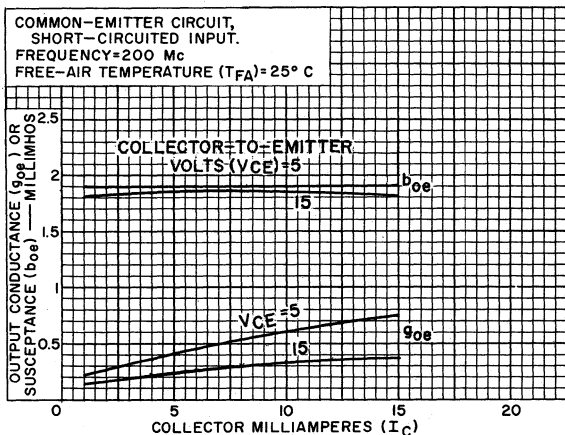
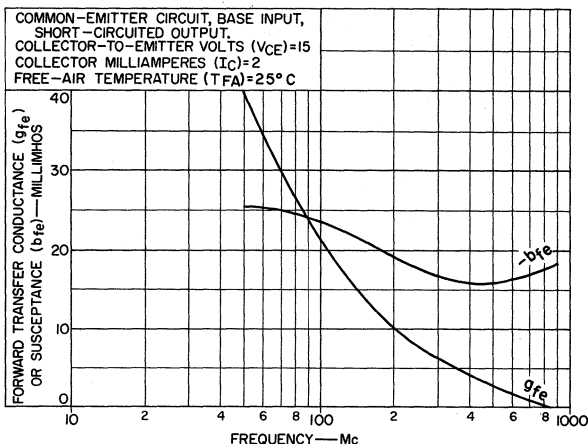
92CS-11932



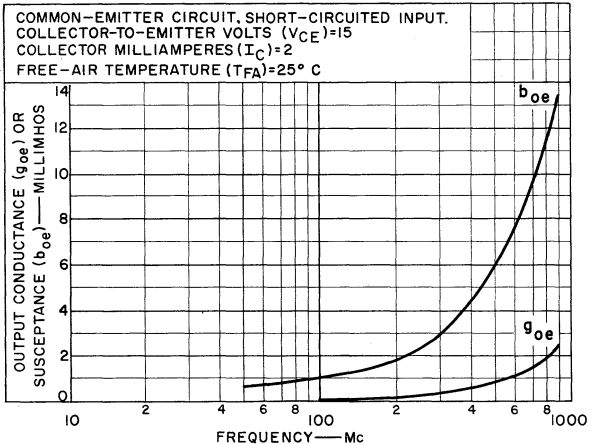
TYPICAL SMALL-SIGNAL "Y" PARAMETER CHARACTERISTICS



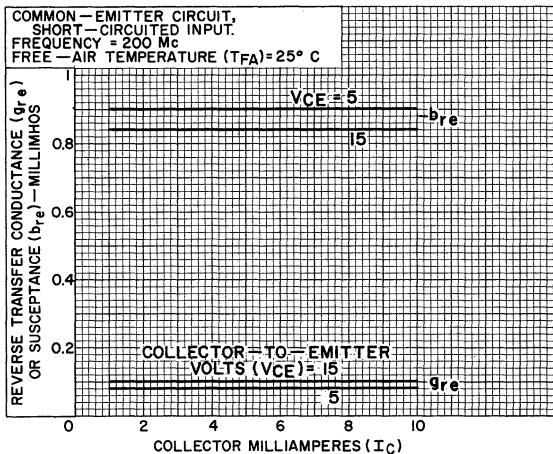
TYPICAL SMALL-SIGNAL "Y" PARAMETER CHARACTERISTICS



TYPICAL SMALL-SIGNAL "Y" PARAMETER CHARACTERISTICS



92CS-11935

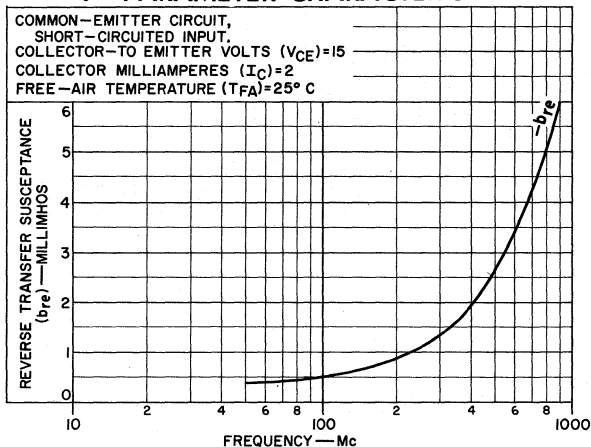


92CS-11939



2N2708

TYPICAL SMALL-SIGNAL "Y" PARAMETER CHARACTERISTIC



Transistor

SILICON N-P-N DOUBLE-DIFFUSED EPITAXIAL-PLANAR TYPE

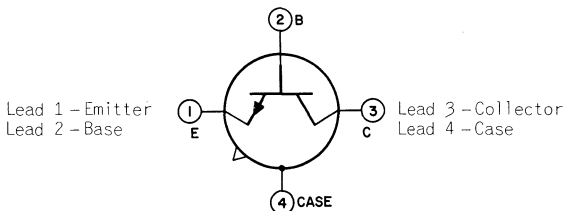
For UHF and VHF Low-Noise-Amplifier, Oscillator, and Converter Service (at frequencies up to 500 Mc in a common-emitter circuit and 1200 Mc in a common-base circuit) in Industrial and Military Applications

Mechanical:

Dimensions. Similar to T0-18 outline except this device has 4 leads
(See Outline T0-18 in General Section)

Terminal Diagram:

BOTTOM VIEW



Maximum and Minimum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage:

With emitter open. V_{CBO} 30 max. volts

Collector-to-Emitter Voltage:

With base open. V_{CEO} 15 max. volts

Emitter-to-Base Voltage:

With collector open. V_{EBO} 2.5 max. volts

Collector Current.

I_C 20 max. ma

Transistor Dissipation:

P_T

At case temperatures:^a

From -65° to 25° C 300 max. mw

Above 25° C Derate linearly 1.72 mw/°C

At free-air temperatures:

From -65° to 25° C 200 max. mw

Above 25° C Derate linearly 1.14 mw/°C

Temperature:

Operating Range (Junction) . T_{opr} -65 to 200 °C

Storage Range. T_{stg} -65 to 200 °C

Leads^b (During soldering):

For 10 seconds maximum . . T_L 230 max. °C



ELECTRICAL CHARACTERISTICS

Free-air temperature = 25° C

Min. Typ. Max.

DC Collector-to-Base Breakdown

Voltage for dc collector ma.

= 0.001, emitter current = 0. . . BV_{CBO} 30 - - volts

DC Collector-to-Emitter

Breakdown Voltage for dc

collector ma. = 3, base

current = 0 BV_{CEO} 15 - - volts

DC Emitter-to-Base Breakdown

Voltage for dc emitter ma. =

0.01, collector current = 0 . . BV_{EBO} 2.5 - - volts

DC Collector-Cutoff Cur-

rent for dc collector-to-

base volts = 15, emitter

current = 0 I_{CBO} - - 0.01 μ a

Input Capacitance for dc

emitter-to-base volts =

0.5, collector current =

0, frequency (kc) = 140,

lead 4 open C_{ib} - 1.4 - pf

Output Capacitance for dc

collector-to-base volts =

10, emitter current = 0,

frequency (kc) = 140,

lead 4 open C_{ob} - - 1.8 pf

lead 4 grounded C_{ob} - - 1.3 pf

DC Forward-Current Transfer

Ratio for dc collector-to-

emitter volts = 1, dc col-

lector ma. = 3. h_{FE} 30 - 150

Small-Signal Short-Circuit

Forward-Current Transfer

Ratio:

With dc collector-to-

emitter volts = 6, dc col-

lector ma. = 2, frequency

(kc) = 1, lead 4 open . . . h_{fe} 50 - 220

With dc collector-to-

emitter volts = 6, dc

collector ma. = 5, fre-

quency (Mc) = 100, lead

4 grounded. h_{fe} 10 - 19

Collector-to-Base Time Con-

stant for dc collector-

to-base volts = 6, dc col-

lector ma. = 2, frequency

(Mc) = 31.9, lead 4 grounded . $r_b'C_c$ 4 - 15 psec



Min. Typ. Max.

Small-Signal Common Emitter

Power Gain^c for dc collector-to-emitter volts = 6,
dc collector ma. = 1.5, frequency (Mc) = 450, lead 4 grounded.

G_{pe} 12.5 - 19 db

UHF Noise Figure for dc collector-to-emitter volts = 6, dc collector ma. = 1.5, source resistance (ohms) = 50, frequency (Mc) = 450, lead 4 grounded

NF - 4 4.5 db

Power Output^d as oscillator for dc collector-to-base volts = 10, dc emitter ma. = -12, frequency (Mc) = 500, lead 4 grounded

P_o 30 - - mW

^a Measured at center of seating plane.

^b Measured along lead at distances equal to or greater than 1/32" from seating plane.

^c See accompanying *Neutralized-Amplifier Circuit*.

^d See accompanying *Oscillator Circuit*.

OPERATING CONSIDERATIONS

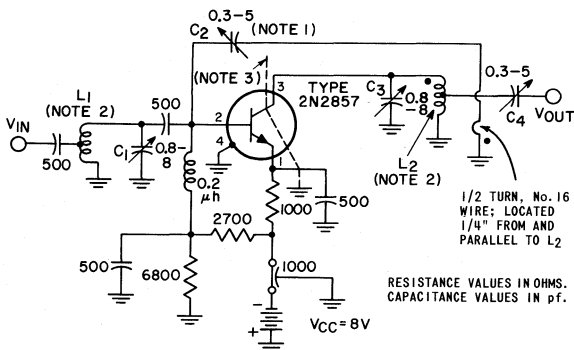
This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.



NEUTRALIZED-AMPLIFIER CIRCUIT

For Power Gain Measurement at 450 Mc



92CS-12140

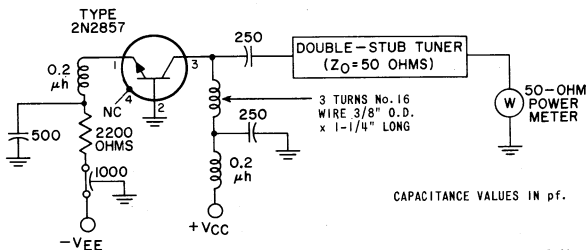
NOTE 1: (NEUTRALIZATION PROCEDURE): (a) Connect a 450-Mc signal generator (with $Z_{out} = 50$ ohms) to input terminals of amplifier. (b) Connect a 50-ohm R-F voltmeter across output terminals of amplifier. (c) Apply V_{EE} and V_{CC} , and with signal generator adjusted for 10 mv output, tune C_1 , C_3 , and C_4 for maximum output. (d) Interchange connections to signal generator and output indicator. (e) With sufficient signal applied to output terminals of amplifier, adjust C_2 for minimum indication at input. (f) Repeat steps (a), (b), and (c) to determine if retuning is necessary.

NOTE 2: L₁ & L₂ — Silver-plated brass rod, 1-1/2" long x 1/4" diameter. Install at least 1/2" from nearest vertical chassis surface. Tap 1-1/4" from chassis end.

NOTE 3: External interlead shield to isolate collector lead from emitter and base leads.



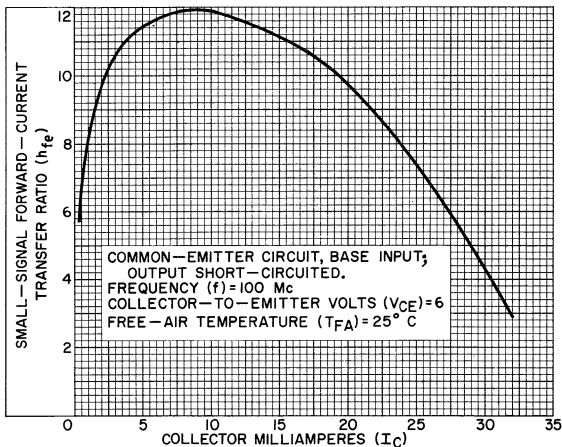
OSCILLATOR CIRCUIT For Power Output Measurement at 500 Mc



92CS-12141

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SMALL-SIGNAL FORWARD-CURRENT TRANSFER RATIO CHARACTERISTIC



92CS-12153

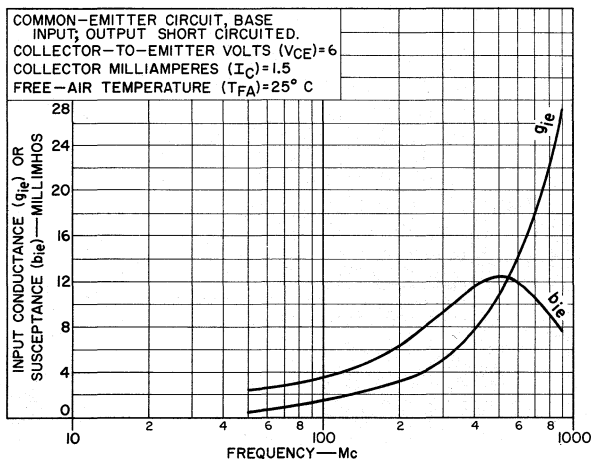
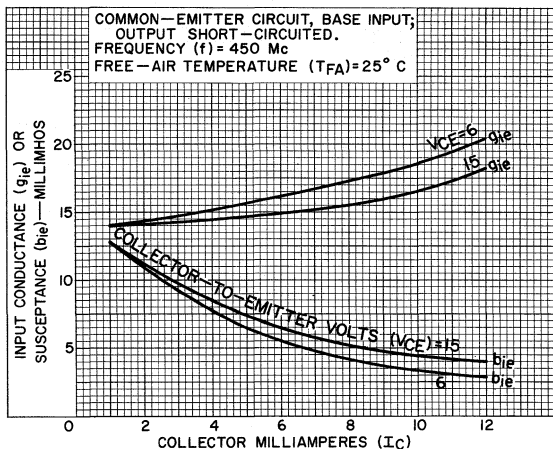


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Electronic Components and Devices
Harrison, N. J.

DATA 3
10-63

"Y" Parameters, Two-Port Admittance Curves

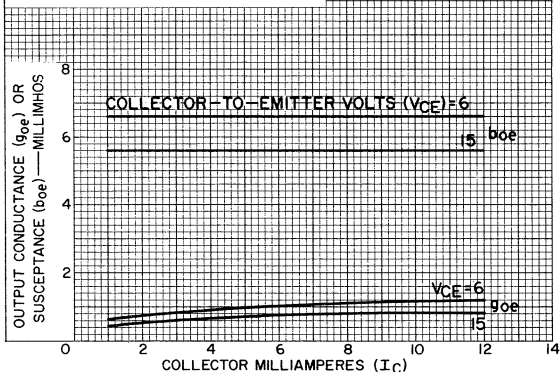
INPUT ADMITTANCE (y_{ie})



"Y" Parameters, Two-Port Admittance Curves

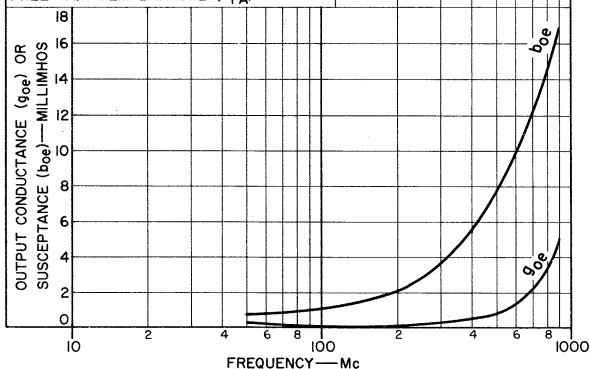
OUTPUT ADMITTANCE (y_{oe})

COMMON-EMITTER CIRCUIT; INPUT
SHORT-CIRCUITED.
FREQUENCY (f) = 450 Mc
FREE-AIR TEMPERATURE (T_{FA}) = 25° C



92CS-12148

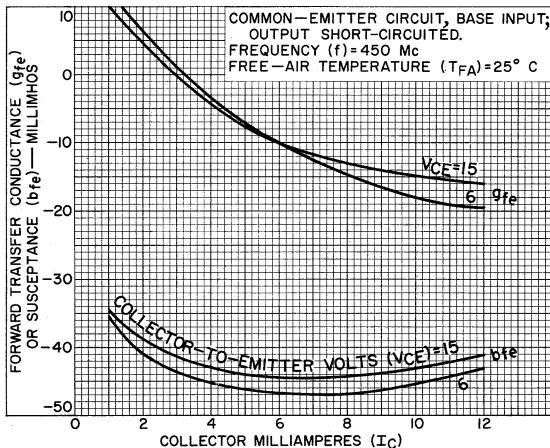
COMMON-EMITTER CIRCUIT; INPUT
SHORT-CIRCUITED.
COLLECTOR-TO-EMITTER VOLTS (V_{CE}) = 6
COLLECTOR MILLIAMPERES (I_C) = 1.5
FREE-AIR TEMPERATURE (T_{FA}) = 25° C



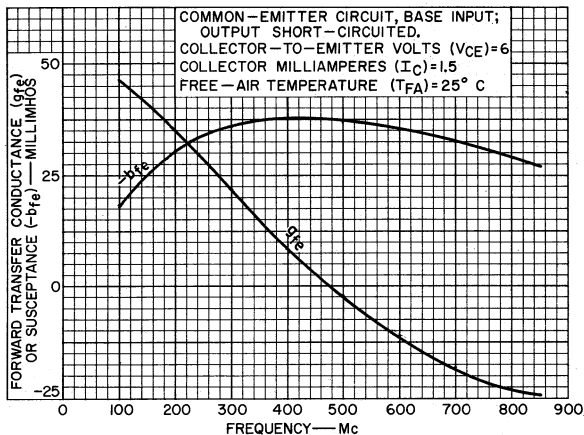
92CS-12156



"Y" Parameters, Two-Port Admittance Curves FORWARD TRANSADMITTANCE (y_{fe})



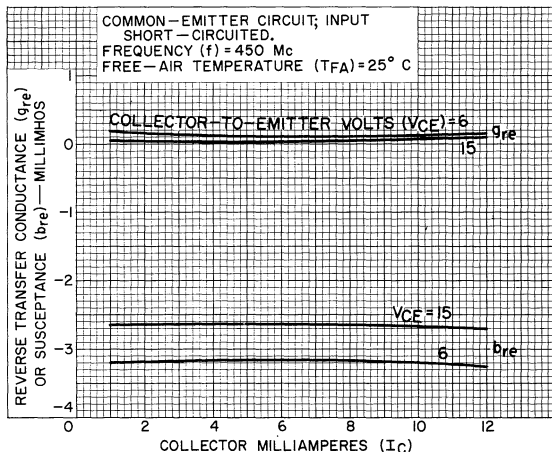
92CS-12149



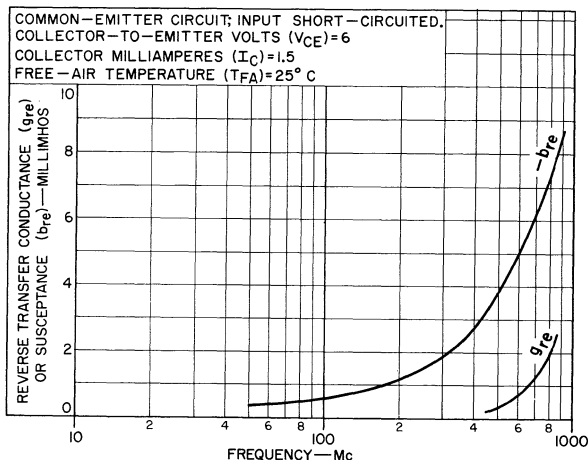
92CS-12152



"Y" Parameters, Two-Port Admittance Curves
 REVERSE TRANSADMITTANCE (y_{oe})



92CS-12154



92CS-12151R1



2N2869/2N301

Power Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

For AF Power-Amplifier and other Large-Signal Applications in Commercial, Industrial, and Military Equipment

The 2N2869/2N301 is a Direct Replacement for Type 2N301

GENERAL DATA

Mechanical:

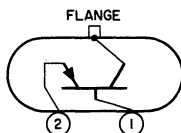
Dimensions. See Outline TO-3 in General Section

Pin Length. 0.440" - 0.480"

Maximum Mounting-flange Thickness. 0.050"

Terminal Diagram: BOTTOM VIEW

Pin 1 - Base
Pin 2 - Emitter



MOUNTING FLANGE-
Collector,
Case

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open. V_{CBO} -60 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With base open. V_{CBO} -50 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open. V_{EBO} -10 max. volts

COLLECTOR CURRENT. I_C -10 max. amp

EMITTER CURRENT. I_E 10 max. amp

BASE CURRENT. I_B -3 max. amp

TRANSISTOR DISSIPATION:

At mounting-flange temperatures^a

From -65° to 55° C. 30 max. watts

Above 55° C. Derate linearly 0.66 watt/°C

TEMPERATURE:

Operating Range (Junction). T_{OPR} -65 to 100 °C

Storage Range. T_{STG} -65 to 100 °C

Pin:^b

For 10 seconds maximum. T_P 225 max. °C

ELECTRICAL CHARACTERISTICS

Mounting-flange temperature^a = 25° C

Min. Typ. Max.

DC Collector-to-Base

Breakdown Voltage

for dc collector

amperes = -0.005,

emitter current = 0 . . . BV_{CBO} -60 - - volts



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Electronic Components and Devices
Harrison, N. J.

DATA 1
8-63

2N2869/2N301

Min. Typ. Max.

DC Collector-to-Emitter Breakdown Voltage for dc collector amperes = -0.6, base current = 0	BV_{CEO}	-50	-	-	volts
DC Emitter-to-Base Breakdown Voltage for dc emitter ma. = -2, collector current = 0	BV_{EBO}	-10	-	-	volts
DC Collector-to-Emitter Saturation Voltage for dc collector amperes = -10, base amperes = -1	$V_{CE(sat)}$	-	-0.4	-0.75	volt
DC Base-to-Emitter Voltage for dc collector-to-emitter volts = -2, dc collector amperes = -1	V_{BE}	-	-0.3	-0.5	volt
DC Collector-Cutoff Current for dc collector-to-emitter volts = -30, base current = 0	I_{CEO}	-	-	-100	ma
DC Collector-Cutoff Current for dc collector-to-base volts = -30, emitter current = 0	I_{CBO}	-	-	-0.5	ma
DC Collector-Cutoff Saturation Current for dc collector-to-base volts = -0.5, emitter current = 0	$I_{CBO(sat)}$	-	-	-0.1	ma
DC Emitter-Cutoff Current for dc emitter-to-base volts = -10, collector current = 0	I_{EBO}	-	-	2	ma
DC Forward-Current Transfer Ratio for dc collector-to-emitter volts = -2, dc collector amperes = -1	h_{FE}	50	90	165	
Gain-Bandwidth Product for dc collector-to-emitter volts = -2, dc collector amperes = -1	f_T	200	450	-	kc

Typical Operation:

In class A_1 audio-frequency power-amplifier circuit at mounting-flange temperature^a of 80° C

DC Collector Supply Voltage	-14.4	volts
DC Collector-to-Emitter Voltage	-12.2	volts

RADIO CORPORATION OF AMERICA
Electronic Components and Devices

Harrison, N. J.



DC Base-to-Emitter Voltage.	-0.35	volt
Zero-Signal DC Collector Current.	-0.9	amp
Signal Frequency.	400	cps
Signal Source Impedance.	10	ohms
Load Impedance.	15	ohms
Zero-Signal Collector Dissipation.	11	watts
Circuit Efficiency ^c (At power output of 5 watts).	45	%
Maximum Total Harmonic Distortion		
(At power output of 5 watts).	5	%
Power Gain ^c	38	db
Maximum Signal Power Output ^c	5	watts

In class B push-pull audio-frequency power amplifier circuit at mounting-flange temperature^a of 80° C

Unless otherwise specified, values are for two transistors

DC Collector Supply Voltage.	-14.4	volts
Zero-Signal DC Base-to-Emitter Voltage.	-0.13	volt
Zero-Signal DC Collector Current (Per transistor).	-0.05	amp
Maximum Signal DC Collector Current (Per transistor).	-0.64	amp
Peak Collector Current (Per transistor).	-2	amp
Signal Frequency.	400	cps
Signal Source Impedance (Per base).	10	ohms
Load Impedance (Per collector).	6	ohms
Collector Dissipation (Per transistor at power output of 12 watts).	3	watts
Circuit Efficiency ^c (At power output of 12 watts).	67	%
Maximum Total Harmonic Distortion (At power output of 12 watts).	5	%
Power Gain ^c	30	db
Maximum Signal Power Output ^c	12	watts

^a Measured at center of seating plane.

^b Measured along pin at distances not less than 1/32" from seating plane.

^c Measured at the primary of the output transformer.

OPERATING CONSIDERATIONS

In class A service, to insure stable operation and low distortion, it will be necessary to provide some degeneration in the emitter circuit. This degeneration may be accomplished by using an unbypassed resistor in the emitter circuit.

In class B service, if this transistor is operated near its maximum collector voltage rating, it is important that circuit arrangements be made to prevent thermal runaway. A convenient method is to reduce the base-to-emitter forward voltage by an amount equal to approximately 0.002 volt for each degree centigrade that the mounting-flange temperature is above 25° C.

In the design of circuits using this transistor it is extremely important to assure that the maximum junction-temperature rating of 100° C is not exceeded. This consideration is



2N2869/2N301

especially important in af-amplifier and other applications involving complex signal waveforms and other factors capable of producing high peak values of dissipation, such as

- (1) phase shifts due to circuit capacitances and/or reactive loads
- (2) oscillation or "ringing" due to excessive or improperly neutralized feedback
- (3) high line voltage
- (4) variations in load impedance
- (5) overdriving of transistors

Because of the short thermal time constant of this transistor (approximately 15 milliseconds), the rise in junction temperature produced when so-called "instantaneous" peak values of dissipation are sustained for longer than 15 milliseconds may be as great as 1.5°C per watt. The circuit designer, therefore, must select operating conditions such that no possible combination of factors listed above, or any other operating condition will cause the junction temperature to rise above 100°C .

Because the metal case of this transistor operates at the collector voltage, consideration should be given to the possibility of shock hazard if the case is to operate at a voltage appreciably above or below ground potential, therefore, suitable precautionary measures should be taken.

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

This transistor can be installed in a commercially available socket. Electrical connection to the base and emitter pins may also be made by soldering directly to the pins. Such connections may be soldered to the pins provided care is taken to conduct excessive heat away from the seals. Otherwise the heat of the soldering operation will crack the pin seals and damage the transistor.

It is essential that the mounting flange which serves as the collector terminal be securely fastened to a heat sink, which may be the equipment chassis. *Under no circumstances, however, should the mounting flange be soldered to the heat sink or chassis because the heat of the soldering operation will permanently damage the transistor.*

The mounting-flange temperature of this transistor will be higher than the ambient (free-air) temperature by an amount which depends on the heat sink used. The heat sink must have sufficient thermal capacity to assure that the heat dissipated in the heat sink itself does not raise the transistor-mounting-flange temperature above the design value.

Depending on the application, the heat sink or chassis may be connected to either the positive or negative terminal of the voltage supply.

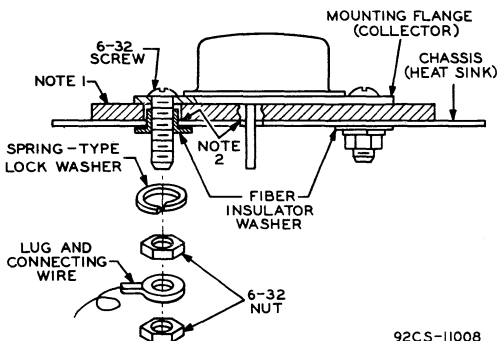
In applications where the chassis is connected to the positive terminal of the voltage supply, it will be necessary to use an anodized-aluminum washer having high thermal conduc-



tivity, or a 0.002" thick mica insulator between the mounting flange and the chassis. If an aluminum washer is used, it should be drilled or punched to provide the two mounting holes and the clearance holes for the emitter and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolts and the chassis, it is important that a fiber washer be used between each bolt and the chassis. See *Suggested Mounting Arrangement*.

An insulated mounting arrangement such as that described in the preceding paragraph and shown in the *Suggested-Mounting-Arrangement* is also necessary when this transistor is used in class B push-pull af-amplifier stages. In such stages the mounting flanges of the two transistors must be insulated from the chassis or heat sink and from each other to avoid short-circuiting the primary winding of the output transformer.

SUGGESTED MOUNTING ARRANGEMENT



92CS-11008

NOTE 1: 0.002" MICA INSULATOR OR ANODIZED ALUMINUM INSULATOR (DRILLED OR PUNCHED WITH BURRS REMOVED).

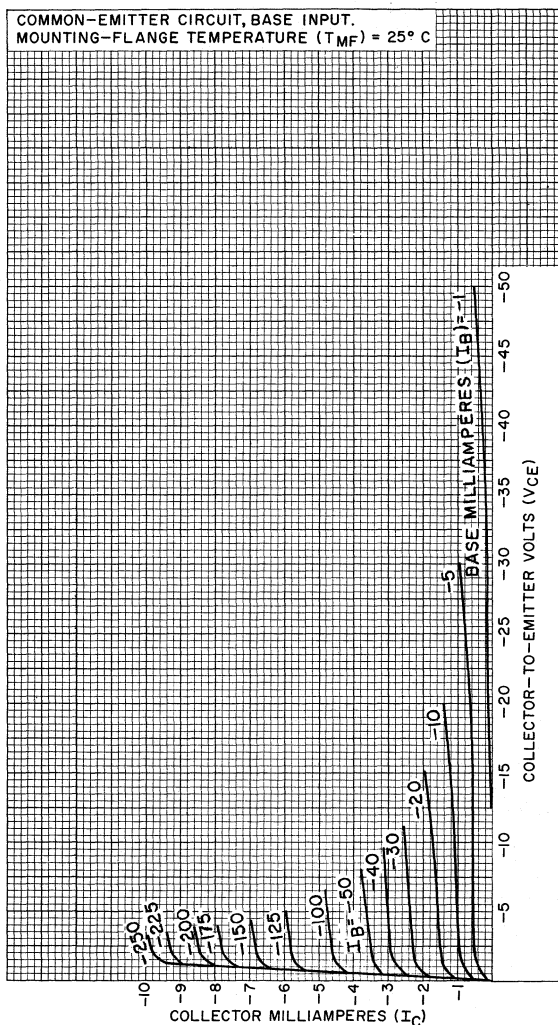
NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.



2N2869/2N301

TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
MOUNTING-FLANGE TEMPERATURE (T_{MF}) = 25° C



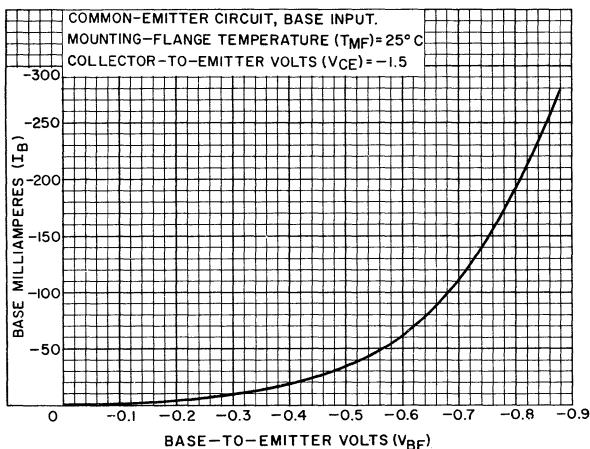
92CM-9247R2

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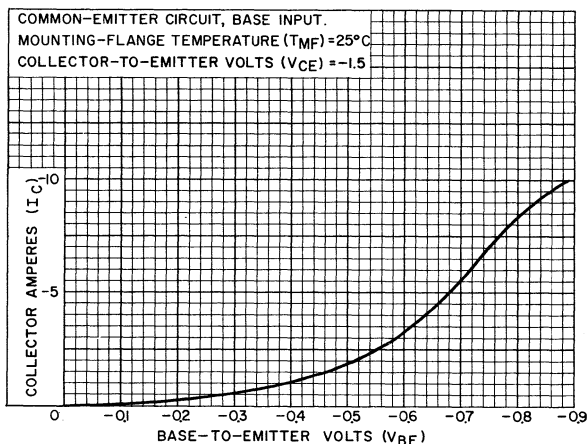


TYPICAL INPUT CHARACTERISTIC



92CS-9248R2

TYPICAL TRANSFER CHARACTERISTIC

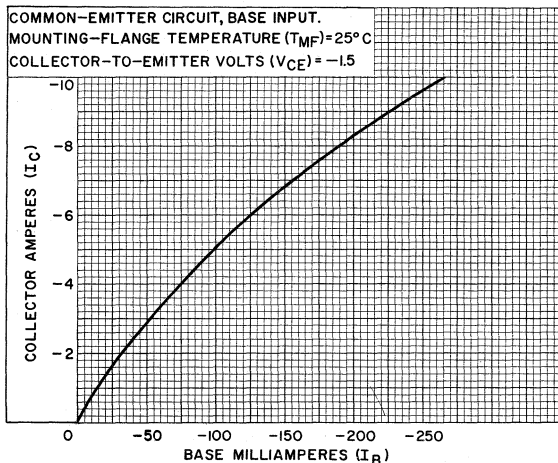


92CS-9249R4



2N2869/2N301

TYPICAL CURRENT-TRANSFER CHARACTERISTIC



92CS-9250R3



2N2870/2N301A

Power Transistor

GERMANIUM P-N-P ALLOY-JUNCTION TYPE

For AF Power-Amplifier and other Large-Signal Applications in Commercial, Industrial, and Military Equipment

The 2N2870/2N301A is a Direct Replacement for Type 2N301A

The 2N2870/2N301A is the same as the 2N2869/2N301 except for the following items:

Maximum and Minimum Ratings, Absolute Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} -80 max. volts

ELECTRICAL CHARACTERISTICS

Mounting-flange temperature^a = 25°C

Min. Typ. Max.

DC Collector-to-Base Break-

down Voltage for dc

amperes = 0.005, emitter

current = 0 BV_{CBO} -80 - - volts

DC Collector-to-Emitter

Saturation Voltage for dc

collector amperes = -10,

base amperes = -1 $V_{CE(sat)}$ - -0.3 -0.5 volt

^a Measured at center of seating plane.



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DATA
8-63

Transistor

SILICON N-P-N TRIPLE-DIFFUSED-JUNCTION PLANAR TYPE

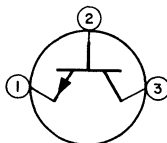
For Large-Signal, High-Power VHF Applications in
Industrial and Military Communications Equipment

GENERAL DATA

Mechanical:

Dimensions. See accompanying *Dimensional Outline*
Terminal Diagram. . . (See accompanying *Dimensional Outline*):

Pin 1—Emitter
Pin 2—Base



Pin 3—Collector

All electrodes are electrically isolated from case

RADIO-FREQUENCY SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:

With emitter open V_{CBO} 80 max. volts

COLLECTOR-TO-EMITTER VOLTAGE:

With base-to-emitter reverse

bias dc volts = -1.5 V_{CEV} 80 max. volts

With base open. V_{CEO} 60 max. volts

EMITTER-TO-BASE VOLTAGE:

With collector open V_{EB0} 4 max. volts

COLLECTOR CURRENT I_C 2.5 max. amp

TRANSISTOR DISSIPATION:

At case temperatures:^a P_T

From -65° to 25° C 17.5 max. watts

Above 25° C. Derate linearly 0.1 watt/°C

TEMPERATURE:

Operating Range (Junction). T_{OPR} -65 to 200 °C

Storage Range T_{STG} -65 to 200 °C

Pin:^b

For 10 seconds maximum T_P 230 max. °C

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C

Min. Typ. Max.

DC Collector-to-Base

Breakdown Voltage for

dc collector ma. = 0.5,

emitter current = 0. . . BV_{CBO} 80 - - volts



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DATA 1
8-63

Min. Typ. Max.

DC Collector-to-Emitter Breakdown Voltage: With base-to-emitter reverse bias dc volts = -1.5, dc collector ma. = 0.1 . . . BV_{CEV}	80	-	-	volts
With pulse-dc collector ma. = 500, base current = 0 (Sustaining voltage) $BV_{CEO(sus)}$	60	-	-	volts
DC Emitter-to-Base Breakdown Voltage for dc emitter ma. = 0.1, collector current = 0 . . . BV_{EBO}	4	-	-	volts
DC Collector-to-Emitter Saturation Voltage for dc collector amperes = 2.5, dc base amperes = 0.5 $V_{CE(sat)}$	-	-	1	volt
DC Collector-Cutoff Current for dc collector-to-base volts = 30, emitter current = 0 I_{CBO}	-	-	0.1	μ a
Base Spreading Resistance for dc collector-to-emitter volts = 28, dc collector ma. = 250, frequency (Mc) = 400 . . . $r_{bb'}$	-	6	-	ohms
Collector-to-Base Capacitance for dc collector-to-base volts = 30, emitter current = 0, frequency (kc) = 140 C_{ob}	-	-	20	pf
Collector-to-Case Capacitance C_c	-	-	6	pf
Gain-Bandwidth Product for dc collector-to-emitter volts = 28, dc collector ma. = 250 f_T	-	200	-	Mc
RF Power Output, Unneutralized: ^d With dc collector-to-emitter volts = 28, dc collector ma. = 500, rf power input (watts) = 2, frequency (Mc) = 50 P_o	10	-	-	watts



Min. Typ. Max.

With dc collector-to-emitter volts = 28, dc collector ma. = 275, rf power input (watts) = 1, frequency (Mc) = 150 P_o

3 - - watts

- a To measure case temperature, drill a hole approximately 1/8" deep in center of any of the six major faces of the hexagonal flange. Insert thermocouple in the hole and peen edges to seal thermocouple.
- b Measured along pin at distances not less than 1/32" from ceramic wafer.
- c Pulse duration $\leq 5 \mu\text{sec}$, duty factor ≤ 0.01 .
- d See accompanying *Power-Output-Measurement Circuit*.

OPERATING CONSIDERATIONS

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

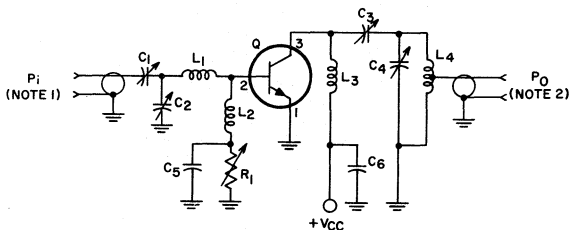
Electrical connections can be made to the pins by means of a commercially available socket, clips, or by soldering directly to the pins. When soldering connections are made to the pins, care should be taken to conduct excessive heat away from the pin seals, otherwise the heat may crack the seals and damage the transistor.

The transistor is provided with a single-ended stud for mounting to a heat sink. The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12-inch pounds.



2N2876

POWER-OUTPUT-MEASUREMENT CIRCUIT Unneutralized Amplifier



92CS-12040RI

NOTE 1: GENERATOR IMPEDANCE = 50 OHMS.

NOTE 2: LOAD IMPEDANCE = 50 OHMS.

For 50-Mc Operation

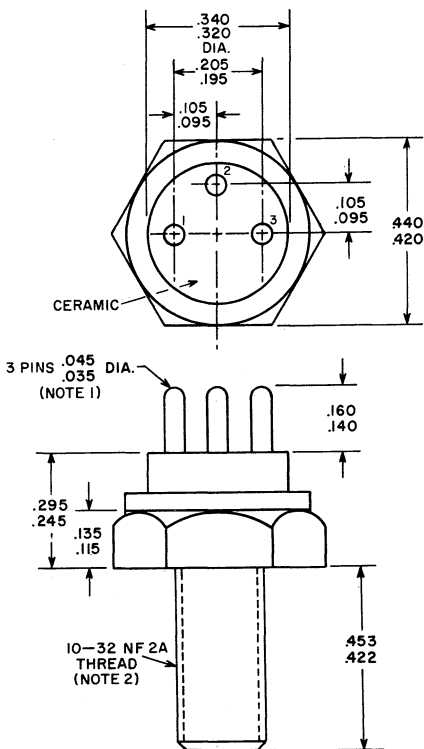
C_1	C_2	C_3	C_4 :	8-60 pf
		C_5	C_6 :	0.005 μ f
			L_1 :	8 turns No. 16 wire, 3/8" inside diameter by 9/16" long
			L_2 :	Ferrite choke, $Z = 150$ ohms $\pm 20\%$
			L_3 :	10 μ h
			L_4 :	7 turns No. 14 wire, 1/2" inside diameter by 7/8" long, tap 2 turns from ground end
			Q:	Transistor type 2N2876
			R_1 :	5000 ohms

For 150-Mc Operation

C_1	C_2	C_3	C_4 :	4-40 pf
		C_5	C_6 :	0.005 μ f
			L_1 :	1 turn No. 16 wire, 1/4" inside diameter by 3/16" long
			L_2 :	Ferrite choke, $Z = 150$ ohms $\pm 20\%$
			L_3 :	1.5 μ h
			L_4 :	3 turns No. 14 wire, 3/8" inside diameter by 3/4" long, tap 1-1/2 turns from ground end
			Q:	Transistor type 2N2876
			R_1 :	50 ohms

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92CS-12045RI

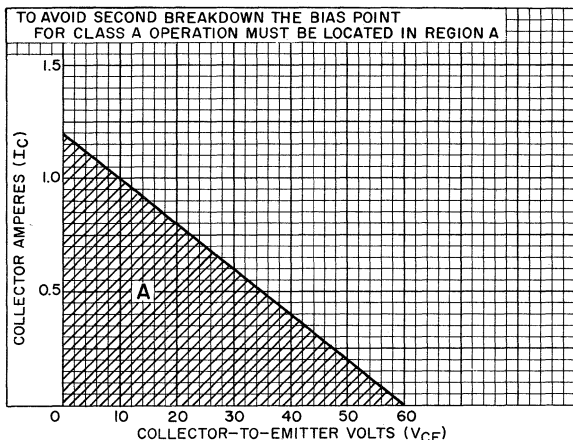
DIMENSIONS IN INCHES

NOTE 1: THE PIN SPACING PERMITS INSERTION IN ANY SOCKET HAVING A PIN-CIRCLE DIAMETER OF 0.200 INCH AND CONTACTS WHICH WILL ACCOMMODATE PINS HAVING A DIAMETER OF 0.035 INCH MINIMUM, 0.045 INCH MAXIMUM.

NOTE 2: THE TORQUE APPLIED TO A 10-32 HEX NUT ASSEMBLED ON THE THREAD DURING INSTALLATION SHOULD NOT EXCEED 12 INCH-POUNDS.

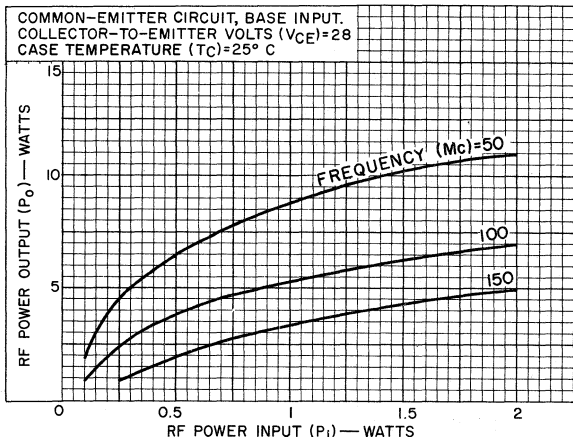


REGION OF SAFE OPERATION Without Second Breakdown in Class A Service



92CS-12038

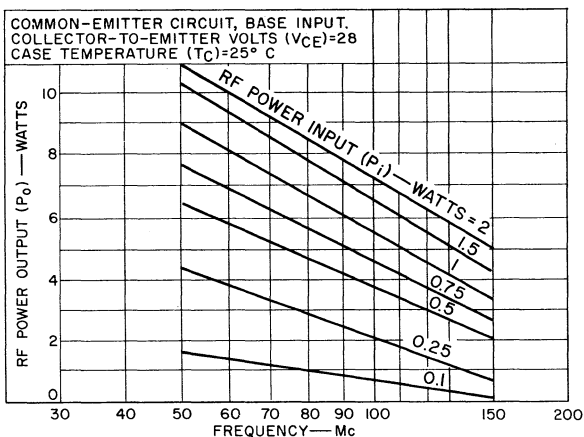
TYPICAL OPERATION CHARACTERISTICS



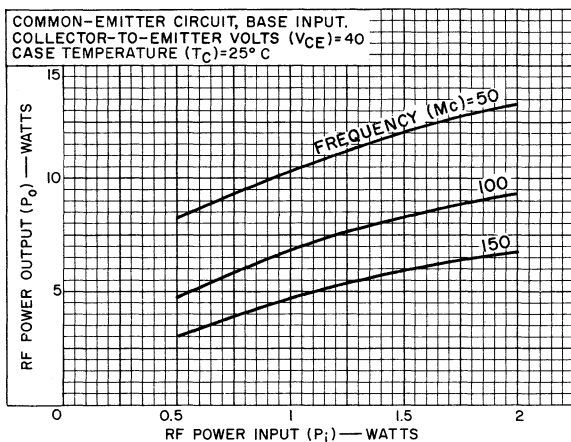
92CS-12062RI



TYPICAL OPERATION CHARACTERISTICS



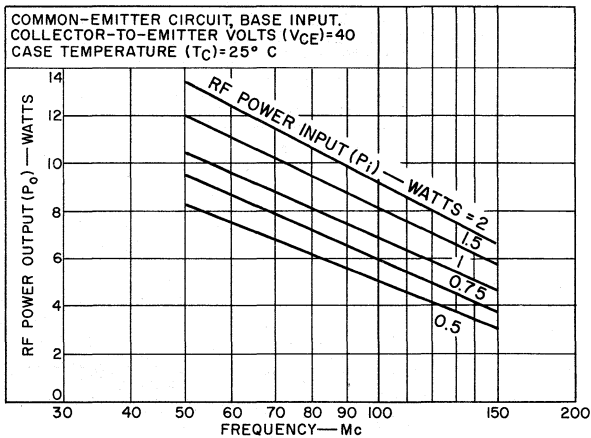
92CS-12061



92CS-12064R1



TYPICAL OPERATION CHARACTERISTICS



92CS-12060



Transistor

SILICON N-P-N TRIPLE-DIFFUSED PLANAR TYPE

For Small-Signal and Low-to-Medium Power Applications in Industrial and Military Equipment

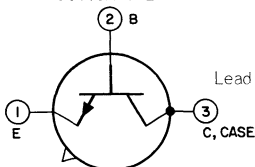
Mechanical:

Dimensions. See Outline T0-18 in General Section

Terminal Diagram

BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

INDUSTRIAL SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage V_{CBO} 120 max. volts
With emitter open

Collector-to-Emitter Voltage

With external base-to-emitter
resistance ≤ 10 ohms.

V_{CER} 80 max. volts

With base open. V_{CEO} 65 max. volts

Emitter-to-Base Voltage V_{EBO} 7 max. volts

With collector open

Collector Current I_C 1 max. amp

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C. P_T 1.8 max. watts

Above 25° C. Derate linearly 0.010 watt/ $^{\circ}$ C

At free-air temperatures:

From -65° to 25° C. P_T 0.5 max. watt

Above 25° C. Derate linearly 0.003 watt/ $^{\circ}$ C

Temperature

Operating range (Junction). T_{opr} -65 to 200 $^{\circ}$ C

Storage range T_{stg} -65 to 200 $^{\circ}$ C

Leads^b (During soldering):

For 10 seconds maximum. T_L 255 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C, unless otherwise specified

Min. Max.

DC Collector-to-Base Breakdown

Voltage BV_{CBO} 120 - volts

$I_C = 0.1$ ma., $I_E = 0$



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DATA 1
1-64

2N2895

		Min.	Max.	
DC Collector-to-Emitter Breakdown Voltage. . . .	BV_{CER}	80	-	volts
I_C (Pulsed) = 100 ma. ^c , R_{BE} = 10 ohms				
DC Emitter-to-Base Breakdown Voltage. . . .	BV_{EBO}	7	-	volts
I_E = 0.1 ma., I_C = 0				
DC Collector-to-Emitter Sustaining Voltage				
I_C (Pulsed) = 100 ma. ^c , R_{BE} = 10 ohms	$V_{CER(sus)}$	80	-	volts
I_C (Pulsed) = 100 ma. ^c , I_B = 0.	$V_{CEO(sus)}$	65	-	volts
DC Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	-	1.2	volts
I_C (Pulsed) = 150 ma. ^c , I_B (Pulsed) = 15 ma. ^c				
DC Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	-	0.6	volt
I_C (Pulsed) = 150 ma. ^c , I_B (Pulsed) = 15 ma. ^c				
DC Collector-Cutoff Current				
V_{CB} = 60 volts, I_E = 0, T_C =				
25° C.	I_{CBO}	-	0.002	μa
150° C.	I_{CBO}	-	2	μa
DC Emitter-Cutoff Current.	I_{EBO}	-	0.002	μa
V_{EB} = 5 volts, I_C = 0				
Input Capacitance.	C_{ib}	-	80	pf
f = 140 kc, V_{EB} = 0.5 volt, I_C = 0				
Output Capacitance	C_{ob}	-	15	pf
f = 140 kc, V_{CB} = 10 volts, I_E = 0				
DC Forward-Current Transfer Ratio				
V_{CE} = 10 volts, I_C =				
0.01 ma.	h_{FE}	10	-	
0.1 ma.	h_{FE}	20	-	
10 ma. ^c (Pulsed)	h_{FE}	35	-	
150 ma. ^c (Pulsed). . . .	h_{FE}	40	120	
500 ma. ^c (Pulsed). . . .	h_{FE}	25	-	
10 ma. ^c (Pulsed), T_C = -55° C.	h_{FE}	20	-	
Small-Signal Short-Circuit Forward-Current Transfer Ratio				
f = 1 kc, V_{CE} = 5 volts, I_C = 5 ma.				
f = 20 Mc, V_{CE} = 10 volts, I_C = 50 ma.	h_{fe}	50	200	
	h_{fe}	6	-	



		Min.	Max.	
Noise Figure	NF	-	8	db
Circuit bandwidth = 1 cps, f = 1 kc, $R_G = 510$ ohms, $V_{CE} = 10$ volts, $I_C = 0.3$ ma.				

Thermal Resistance

Junction-to-case	θ_{JC}	-	97	$^{\circ}\text{C}/\text{watt}$
Junction-to-free-air	θ_{JFA}	-	350	$^{\circ}\text{C}/\text{watt}$

- a Measured at center of seating plane.
b Measured along lead at distances not less than $1/32"$ from seating plane.
c pulse duration = 300 μ seconds, duty factor = 0.018.

OPERATING CONSIDERATIONS

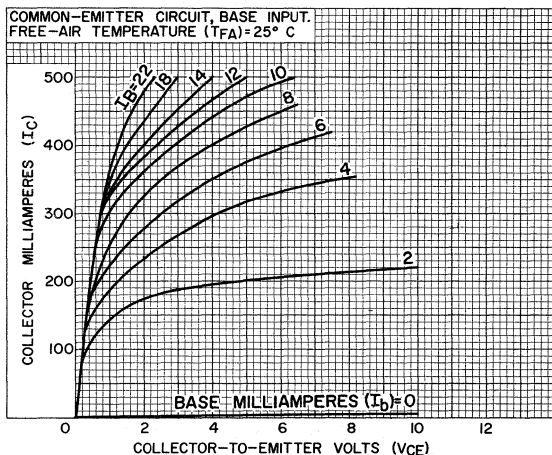
This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

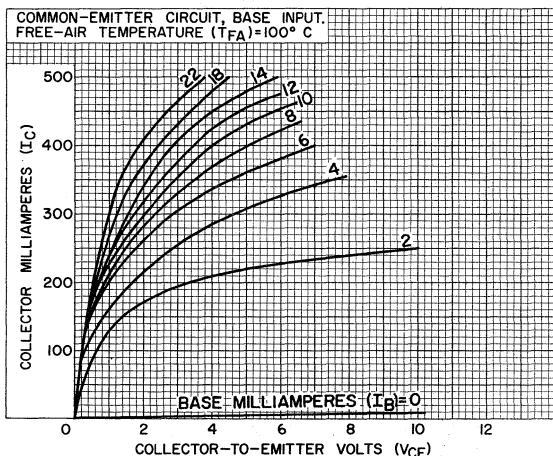
It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



TYPICAL COLLECTOR CHARACTERISTICS



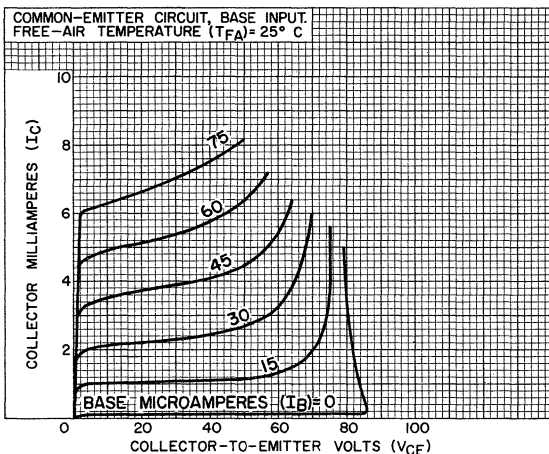
92CS-11176



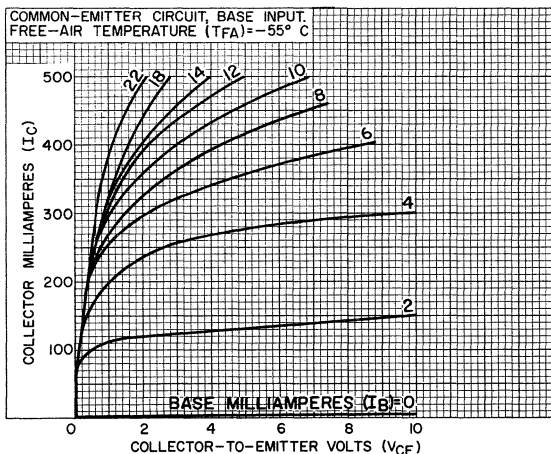
92CS-11177



TYPICAL COLLECTOR CHARACTERISTICS



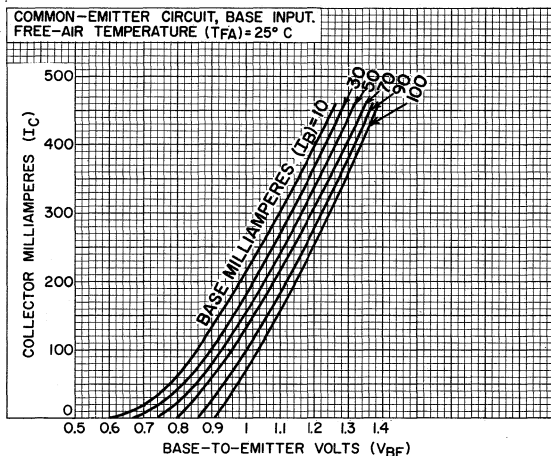
92CS-III75



92CS-III90



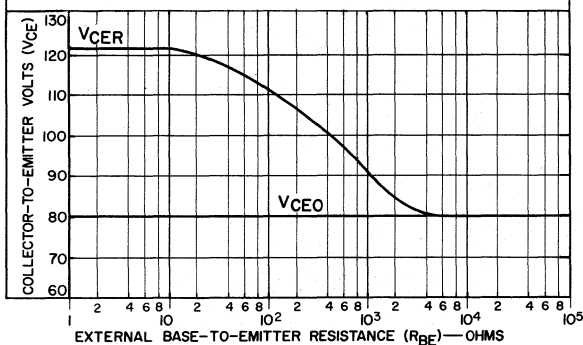
TYPICAL TRANSFER CHARACTERISTICS



92CS-11185

TYPICAL COLLECTOR-TO-EMITTER-VOLTAGE CHARACTERISTICS

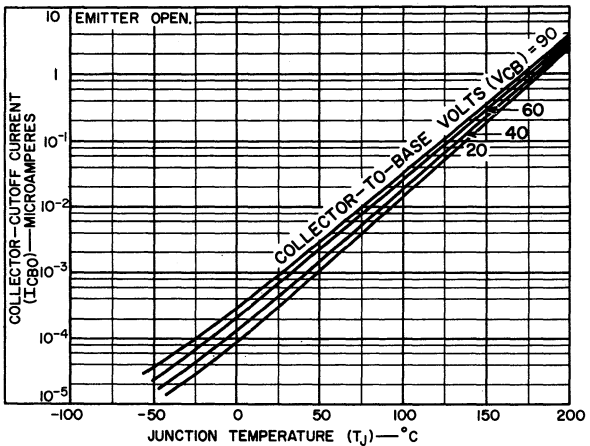
V_{CEr} = COLLECTOR-TO-EMITTER VOLTAGE WITH EXTERNAL RESISTANCE
BETWEEN BASE AND EMITTER
 V_{CE0} = COLLECTOR-TO-EMITTER VOLTAGE WITH BASE OPEN
COLLECTOR CURRENT (I_C) = 100 MA.
FREE-AIR TEMPERATURE (T_{FA}) = 25° C



92CS-12119

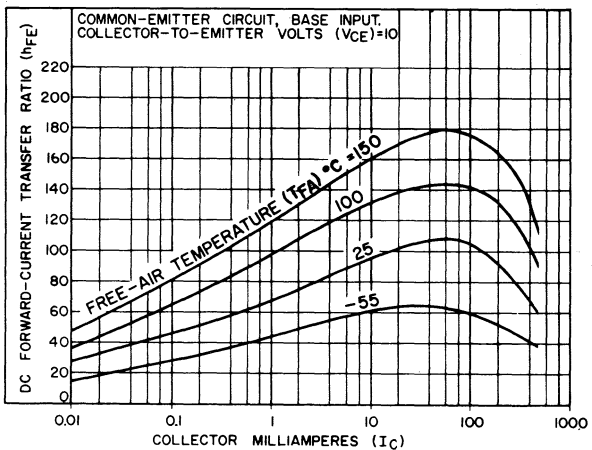


TYPICAL COLLECTOR-CUTOFF-CURRENT CHARACTERISTICS



92CS-12124

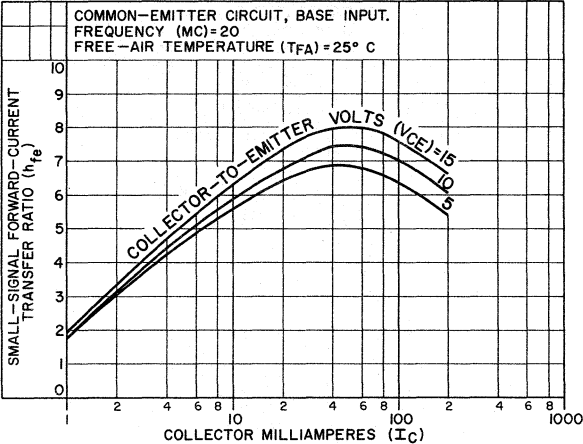
TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



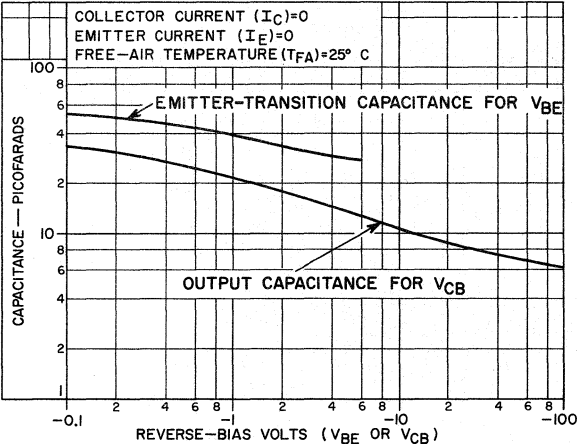
92CS-12115



TYPICAL SMALL-SIGNAL FORWARD-CURRENT
TRANSFER-RATIO CHARACTERISTICS

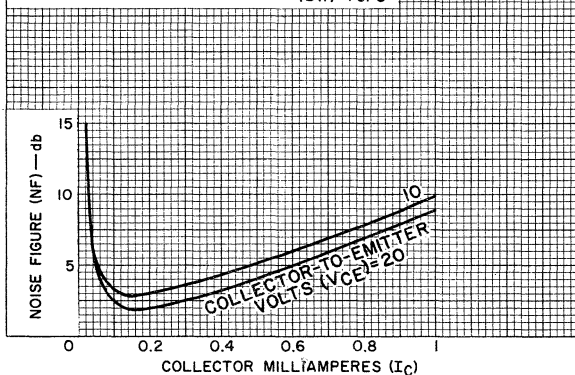


TYPICAL CAPACITANCE CHARACTERISTICS



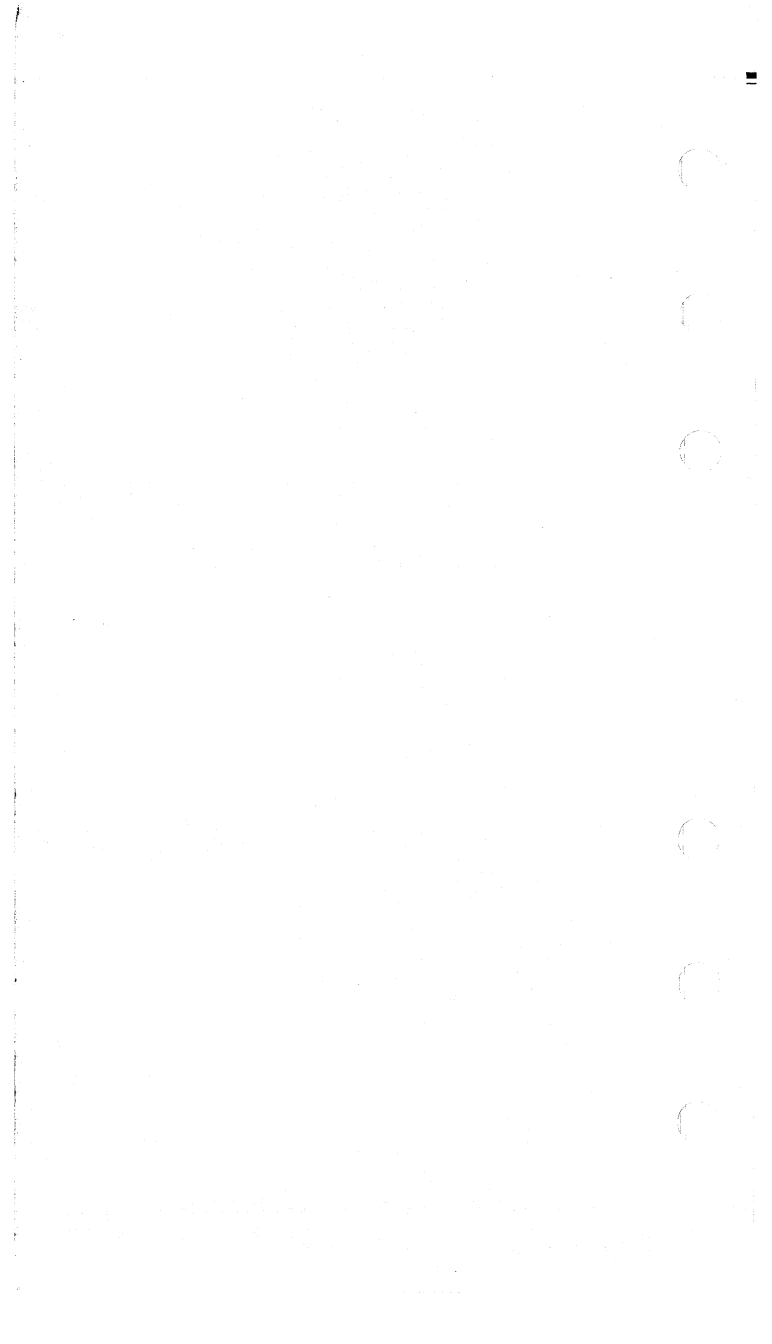
TYPICAL AF NOISE FIGURE CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE (T_{FA}) = 25° C
GENERATOR RESISTANCE (R_g) = 510 OHMS
SIGNAL FREQUENCY = 1 KC
MEASUREMENT-CIRCUIT BANDWIDTH (BW) = 1 CPS



92CS-12093





Transistor

SILICON N-P-N TRIPLE-DIFFUSED PLANAR TYPE

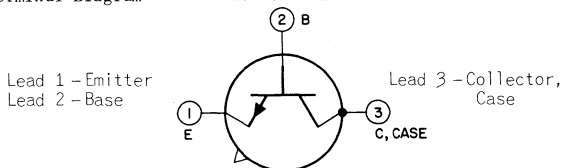
For Small-Signal and Low-to-Medium Power Applications in Industrial and Military Equipment

Mechanical:

Dimensions. See Outline TO-18 in General Section

Terminal Diagram

BOTTOM VIEW



INDUSTRIAL SERVICE

Maximum and Minimum Ratings, *Absolute-Maximum Values:*

Collector-to-Base Voltage. V_{CBO} 140 max. volts
With emitter open

Collector-to-Emitter Voltage

With external base-to-emitter

resistance < 10 ohms V_{CER} 140 max. volts

With base open V_{CEO} 90 max. volts

Emitter-to-Base Voltage. V_{EBO} 7 max. volts

With collector open

Collector Current. I_C 1 max. amp

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C P_T 1.8 max. watts

Above 25° C Derate linearly 0.010 watt/ $^{\circ}$ C

At free-air temperatures:

From -65° to 25° C P_T 0.5 max. watt

Above 25° C Derate linearly 0.003 watt/ $^{\circ}$ C

Temperature

Operating range (Junction) T_{opr} -65 to 200 $^{\circ}$ C

Storage range T_{stg} -65 to 200 $^{\circ}$ C

Leads^b (During Soldering):

For 10 seconds maximum T_L 255 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C, unless otherwise specified
Min. Max.

DC Collector-to-Base Break-

down Voltage. BV_{CBO} 140 - volts

$I_C = 0.1$ ma., $I_E = 0$



		Min.	Max.	
DC Collector-to-Emitter Breakdown Voltage	BV_{CER}	140	-	volts
I_C (Pulsed) = 100 ma.c, $R_{BE} = 10$ ohms				
DC Emitter-to-Base Breakdown Voltage	BV_{EBO}	7	-	volts
$I_E = 0.1$ ma., $I_C = 0$				
DC Collector-to-Emitter Sustaining Voltage	$V_{CER(sus)}$	140	-	volts
I_C (Pulsed) = 100 ma.c, $R_{BE} = 10$ ohms				
I_C (Pulsed) = 100 ma.c, $I_B = 0$	$V_{CEO(sus)}$	90	-	volts
DC Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	-	1.2	volts
I_C (Pulsed) = 150 ma.c, I_B (Pulsed) = 15 ma.c				
DC Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	-	0.6	volt
I_C (Pulsed) = 150 ma.c, I_B (Pulsed) = 15 ma.c				
DC Collector-Cutoff Current				
$V_{CB} = 90$ volts, $I_E = 0$, $T_C = 25^\circ C$				
$150^\circ C$	I_{CBO}	-	0.01	μa
	I_{CBO}		10	μa
DC Emitter-Cutoff Current	I_{EBO}	-	0.01	μa
$V_{EB} = 5$ volts, $I_C = 0$				
Input Capacitance	C_{ib}	-	80	pf
$f = 140$ kc, $V_{EB} = 0.5$ volt, $I_C = 0$				
Output Capacitance	C_{ob}	-	15	pf
$f = 140$ kc, $V_{CB} = 10$ volts, $I_E = 0$				
DC Forward-Current Transfer Ratio				
$V_{CE} = 10$ volts, $I_C = 1$ ma.				
150 ma.c (Pulsed)	h_{FE}	35	-	
10 ma.c (Pulsed), $T_C = -55^\circ C$	h_{FE}	60	200	
	h_{FE}	20	-	
Small-Signal Short-Circuit Forward Current Transfer Ratio				
$f = 1$ kc, $V_{CB} = 5$ volts $I_C = 5$ ma.				
$f = 20$ Mc, $V_{CE} = 10$ volts, $I_C = 50$ ma.	h_{fe}	50	275	
	h_{fe}	6	-	
Thermal Resistance				
Junction-to-case	θ_{JC}	-	97	$^\circ C/watt$
Junction-to-free-air	θ_{JFA}	-	350	$^\circ C/watt$

- a Measured at center of seating plane.
- b Measured along lead at distances not less than $1/32$ " from seating plane.
- c Pulse duration = $300 \mu\text{seconds}$, duty factor = 0.018.

OPERATING CONSIDERATIONS

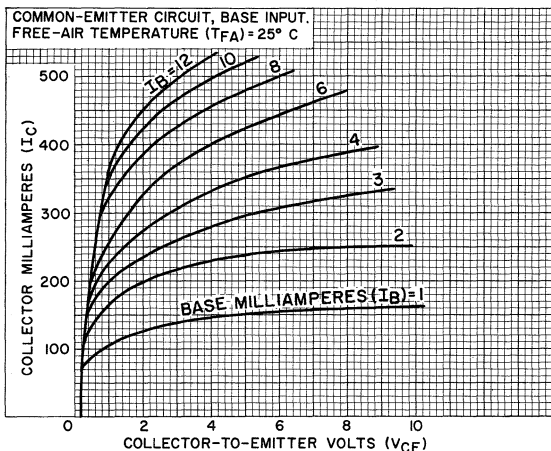
This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

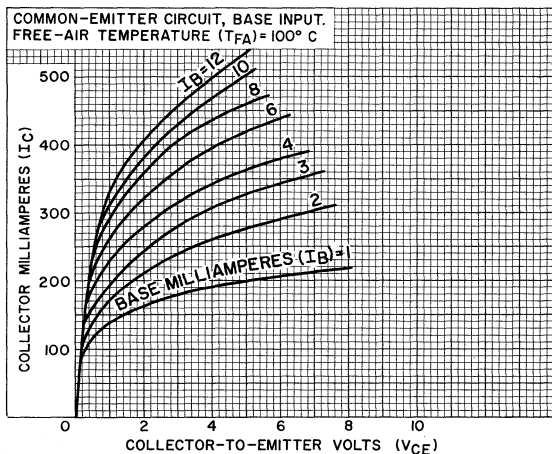
It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



TYPICAL COLLECTOR CHARACTERISTICS



92CS-12097

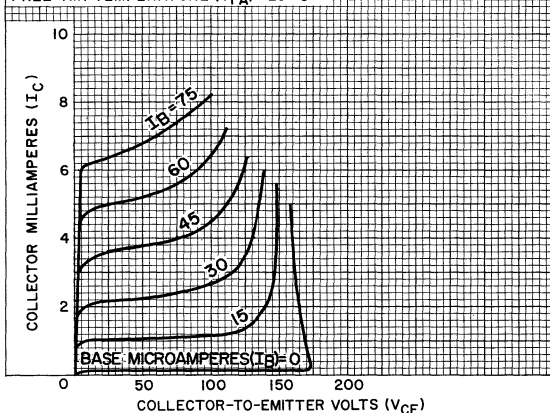


92CS-12102



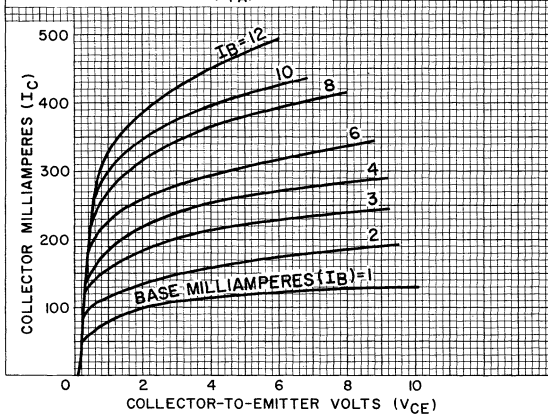
TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
 FREE-AIR TEMPERATURE (T_{FA}) = 25° C



92CS-12094

COMMON-EMITTER CIRCUIT, BASE INPUT.
 FREE-AIR TEMPERATURE (T_{FA}) = -55° C



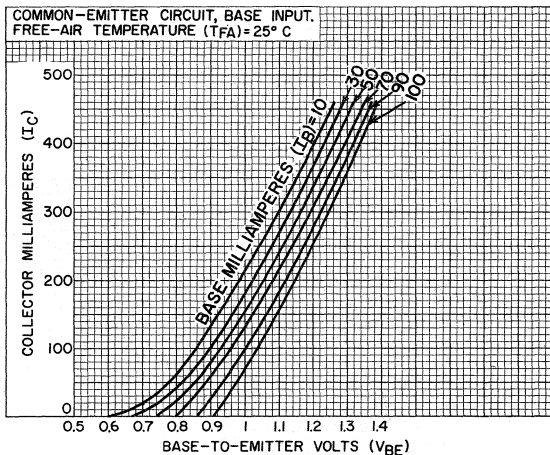
92CS-12099



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 Harrison, N. J.

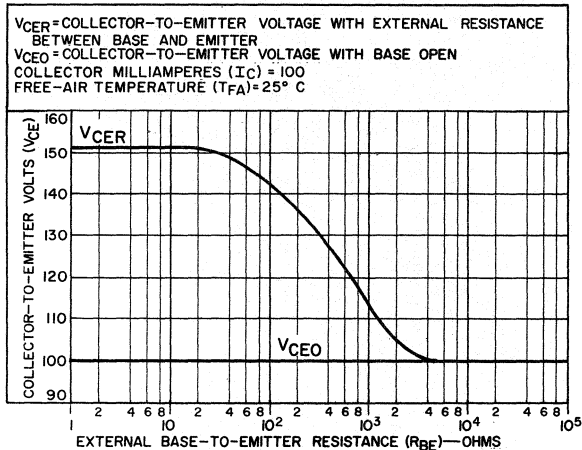
DATA 3
 1-64

TYPICAL TRANSFER CHARACTERISTICS



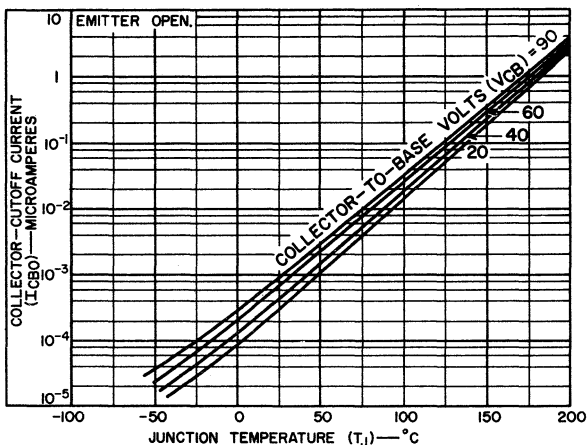
92CS-11185

TYPICAL COLLECTOR-TO-EMITTER VOLTAGE CHARACTERISTICS



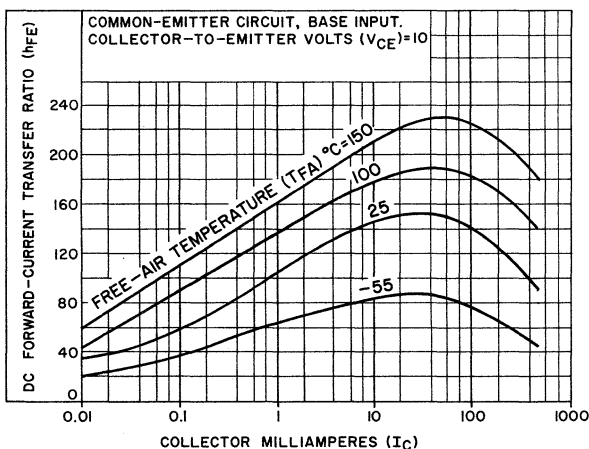
92CS-12122

TYPICAL COLLECTOR-CUTOFF CURRENT CHARACTERISTICS



92CS-12124

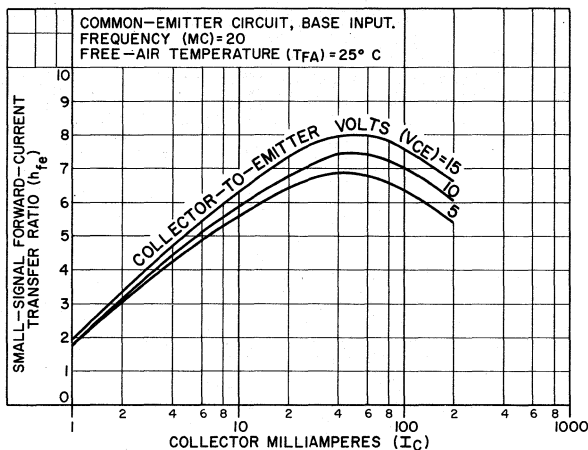
TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



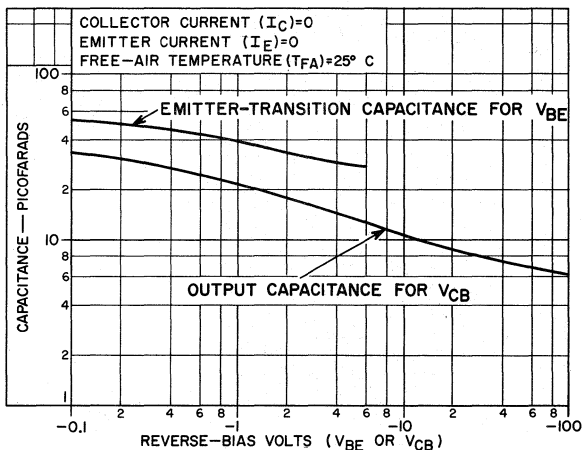
92CS-12123



TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



TYPICAL CAPACITANCE CHARACTERISTICS



Transistor

SILICON N-P-N TRIPLE-DIFFUSED PLANAR TYPE
For Small-Signal and Low-to-Medium Power Applications in Industrial and Military Equipment

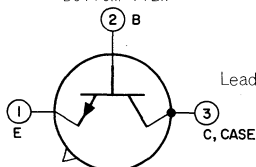
Mechanical:

Dimensions. See Outline TO-18 in General Section

Terminal Diagram

BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

INDUSTRIAL SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage. V_{CBO} 60 max. volts
With emitter open

Collector-to-Emitter Voltage

With external base-to-emitter resistance ≤ 10 ohms

V_{CER} 60 max. volts
With base open V_{CEO} 45 max. volts

Emitter-to-Base Voltage. V_{EBO} 7 max. volts
With collector open

Collector Current. I_C 1 max. amp

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C P_T 1.8 max. watts
Above 25° C Derate linearly 0.010 watt/ $^{\circ}$ C

At free-air temperatures:

From -65° to 25° C P_T 0.5 max. watt
Above 25° C Derate linearly 0.003 watt/ $^{\circ}$ C

Temperature

Operating range (Junction) T_{opr} -65 to 200 $^{\circ}$ C

Storage range. T_{stg} -65 to 200 $^{\circ}$ C

Leads^b (During soldering)

For 10 seconds maximum T_L 255 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Case temperature ^a = 25° C, unless otherwise specified

Min. Max.

DC Collector-to-Base Break-

down Voltage BV_{CBO} 60 - volts

$I_C = 0.1$ ma., $I_E = 0$



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DATA 1
1-64

		Min.	Max.	
DC Collector-to-Emitter Breakdown Voltage				
I_C (Pulsed) = 100 ma.c, $R_{BE} = 10$ ohms	BV_{CER}	60	-	volts
DC Emitter-to-Base Breakdown Voltage				
$I_E = 0.1$ ma., $I_C = 0$	BV_{EBO}	7	-	volts
DC Collector-to-Emitter Sustaining Voltage				
I_C (Pulsed) = 100 ma.c, $R_{BE} = 10$ ohms.	$V_{CER(sus)}$	60	-	volts
I_C (Pulsed) = 100 ma.c, $I_B = 0$	$V_{CEO(sus)}$	45	-	volts
DC Base-to-Emitter Saturation Voltage				
I_C (Pulsed) = 150 ma.c, I_B (Pulsed) = 15 ma.c	$V_{BE(sat)}$	-	1.3	volts
DC Collector-to-Emitter Saturation Voltage				
I_C (Pulsed) = 150 ma.c, I_B (Pulsed) = 15 ma.c	$V_{CE(sat)}$	-	1	volt
DC Collector-Cutoff Current				
$V_{CB} = 60$ volts, $I_E = 0$, $T_C = 25^\circ$ C.	I_{CBO}	-	0.05	μ a
150° C.	I_{CBO}	-	50	μ a
DC Emitter-Cutoff Current				
$V_{EB} = 5$ volts, $I_C = 0$	I_{EBO}	-	0.05	μ a
Input Capacitance				
$f = 140$ kc, $V_{EB} = 0.5$ volt, $I_C = 0$	C_{ib}	-	80	pf
Output Capacitance				
$f = 140$ kc, $V_{CB} = 10$ volts, $I_E = 0$	C_{ob}	-	15	pf
DC Forward-Current Transfer Ratio				
$V_{CE} = 10$ volts, $I_C = 1$ ma.	h_{FE}	35	-	
150 ma.c (Pulsed).	h_{FE}	50	200	
Small-Signal Short-Circuit Forward-Current Transfer Ratio				
$f = 1$ kc, $V_{CB} = 5$ volts, $I_C = 5$ ma.	h_{fe}	50	275	
$f = 20$ Mc, $V_{CE} = 10$ volts, $I_C = 50$ ma.	h_{fe}	5	-	
Thermal Resistance				
Junction-to-case	θ_{JC}	-	97	$^{\circ}$ C/watt
Junction-to-free-air	θ_{JFA}	-	350	$^{\circ}$ C/watt

- a Measured at center of seating plane.
b Measured along lead at distances not less than $1/32$ " from seating plane.
c Pulse duration = 300 μ seconds, duty factor = 0.018.

OPERATING CONSIDERATIONS

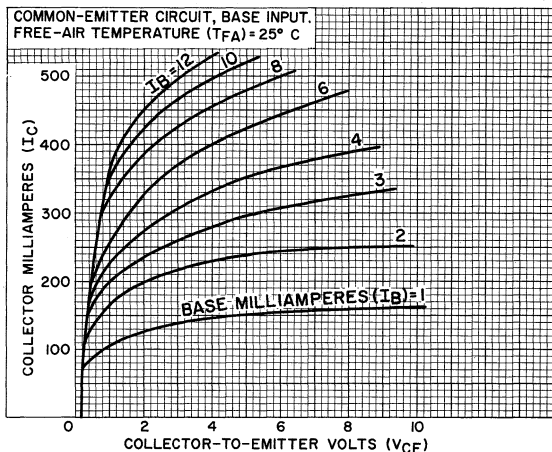
This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

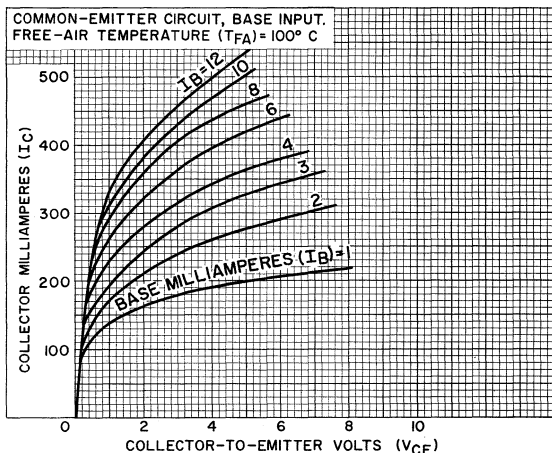
It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



TYPICAL COLLECTOR CHARACTERISTICS



92CS-12097

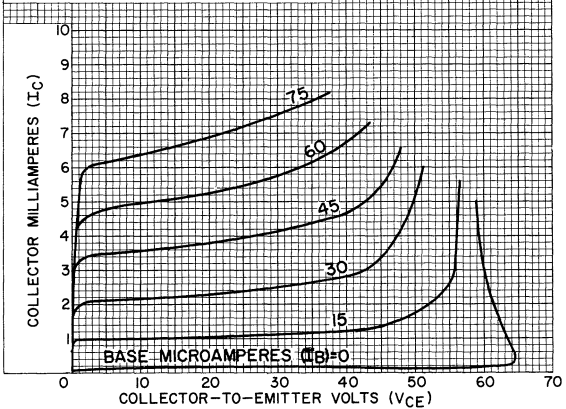


92CS-12102



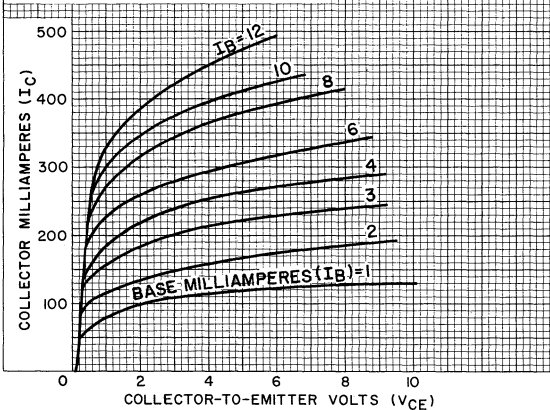
TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE (T_{FA}) = 25° C



92CS-11178

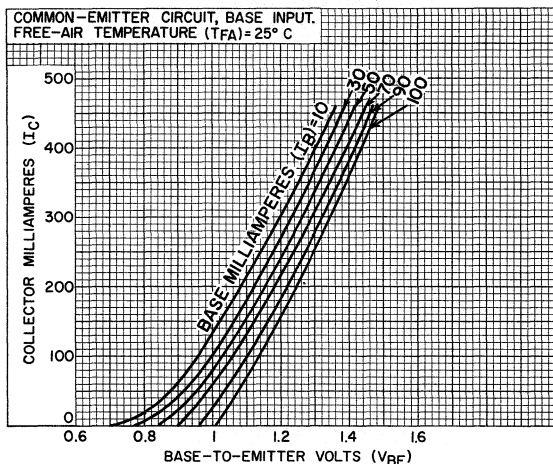
COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE (T_{FA}) = -55° C



92CS-12099

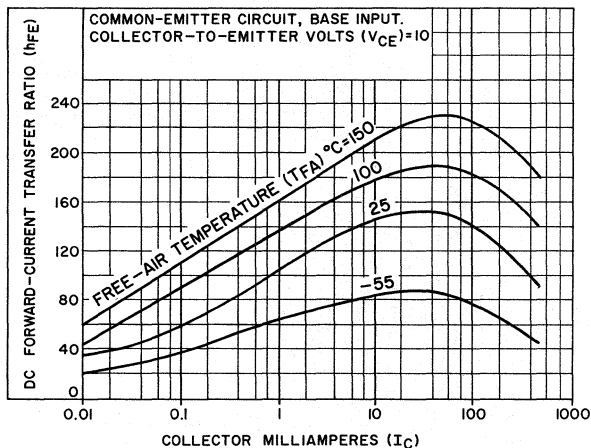


TYPICAL TRANSFER CHARACTERISTICS



92CS-12104

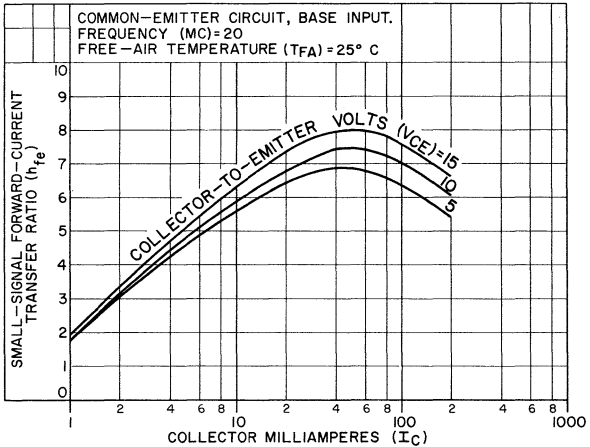
TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



92CS-12123

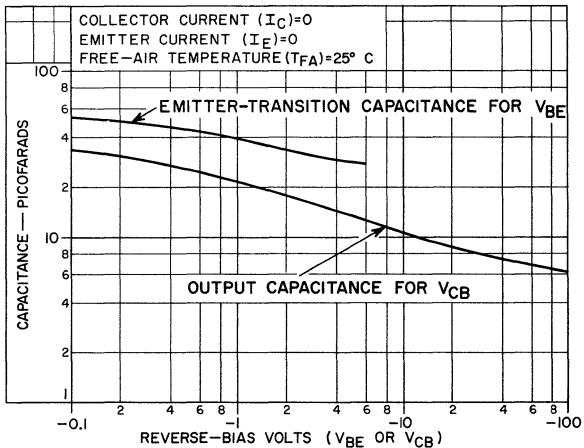


TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



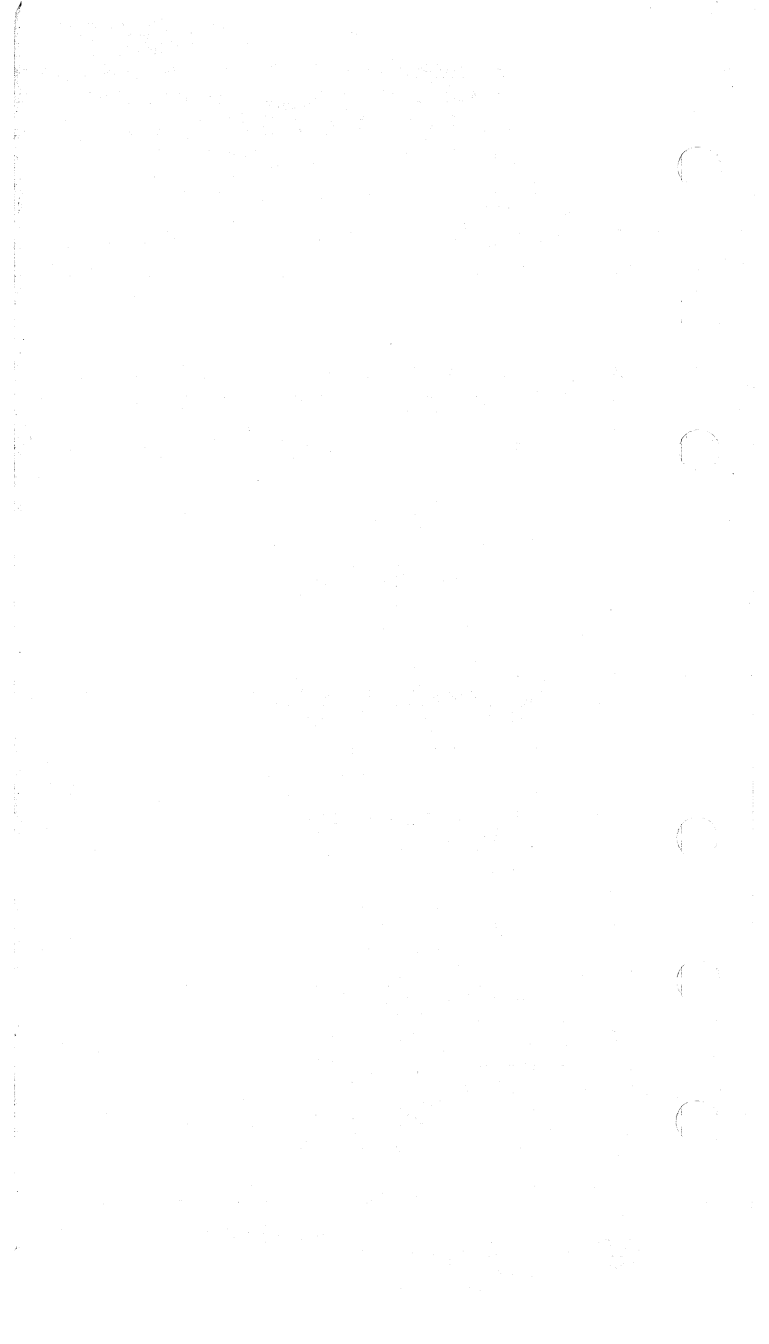
92CS-11171

TYPICAL CAPACITANCE CHARACTERISTICS



92CS-11195





Transistor

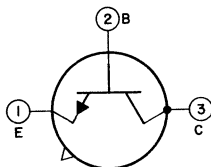
SILICON N-P-N DOUBLE-DIFFUSED EPITAXIAL-PLANAR TYPE

For High-Speed Saturated Switching Applications in
Commercial and Military Data-Processing Systems

Mechanical:

Dimensions. See Outline T0-52 in General Section
Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

SWITCHING SERVICE

Maximum and Minimum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage:

With emitter open V_{CB0} 25 max. volts

Collector-to-Emitter Voltage:

With base open. V_{CE0} 13 max. volts

Emitter-to-Base Voltage:

With collector open V_{EB0} 5 max. volts

Collector Current I_C 500 max. ma

Transistor Dissipation:

At case temperatures:^a

From -65° to 25° C. 1 max. watt

Above 25° C. Derate linearly 0.0067 watt/ $^{\circ}$ C

At free-air temperatures:

From -65° to 25° C. 0.3 max. watt

Above 25° C. Derate linearly 0.002 watt/ $^{\circ}$ C

Temperature:

Operating Range T_{opr} -65 to 175 $^{\circ}$ C

Storage Range T_{stg} -65 to 200 $^{\circ}$ C

Leads^b (During soldering):

For 10 seconds maximum. T_L 300 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Free-air temperature = 25° C, unless otherwise specified

Min. Typ. Max.

DC Collector-to-Base Break-

down Voltage for dc col-

lector ma. = 0.01, emitter

current = 0. BV_{CB0} 25 52 - volts



2N2938

Min. Typ. Max.

DC Collector-to-Emitter Breakdown Voltage for dc collector ma. = 10, base current = 0 BV_{CEO} 13 16 - volts

DC Emitter-to-Base Breakdown Voltage for dc emitter ma. = 0.01, collector current = 0. BV_{EBO} 5 8.5 - volts

DC Base-to-Emitter Saturation Voltage for dc collector ma. = 50, dc base ma. = 1.6. $V_{BE}(sat)$ 0.8 0.85 0.95 volt

DC Collector-to-Emitter Saturation Voltage for dc collector ma. = 50, dc base ma. = 1.6 $V_{CE}(sat)$ - 0.22 0.4 volt

DC Collector-Cutoff Current for dc collector-to-emitter volts = 20, dc emitter-to-base volts = 0, free-air temperature ($^{\circ}C$) =
 25 I_{CEV} - 2.7 25 na
 150. I_{CEV} - 4.2 25 μa

DC Base-Cutoff Current for dc collector-to-emitter volts = 20, dc emitter-to-base volts = 0. I_{BEV} - -2.7 -25 na

Input Capacitance for dc emitter-to-base volts = -1, collector current = 0. C_{ib} - 3.3 5 pf

Output Capacitance at frequency (kc) = 140 for dc collector-to-base volts = 5, emitter current = 0 C_{ob} - 3.5 4 pf

DC Forward-Current Transfer Ratio:
 With dc collector-to-emitter volts = 0.35, dc collector ma. = 10 h_{FE} 25 125 -
 With dc collector-to-emitter volts = 0.4, pulsed-dc collector ma. = 50 $^{\circ}C$ h_{FE} 30 105 -
 With dc collector-to-emitter volts = 1, pulsed-dc collector ma. = 200 $^{\circ}C$ h_{FE} 10 60 -



Min. Typ. Max.

With dc collector-to-emitter
volts = 0.4, pulsed-dc
collector ma. = 50^c, free-
air temperature (°C) = -55. h_{FE}

15 65 -

Small-Signal Short-Circuit**Forward-Current Transfer**

Ratio for dc collector-to-
emitter volts = 10, dc
collector ma. = 10, fre-
quency (Mc) = 100 h_{fe}

5 6.9 -

Switching Time:

Turn-on time^d for dc col-
lector supply volts = 6, dc
collector ma. = 50, turn-
on dc base ma. = 2.5, turn-
off dc base ma. = -2.5. t_{on}

- 24 30 nsec

Turn-off time^d for dc col-
lector supply volts = 6, dc
collector ma. = 50, turn-on
dc base ma. = 2.5, turn-off
dc base ma. = -2.5. t_{off}

- 24 30 nsec

Storage time^e for dc col-
lector supply volts = 10,
dc collector ma. = 10, turn-
on dc base ma. = 10, turn-
off dc base ma. = -10 t_s

- 11 15 nsec

^a Measured at center of seating plane.

^b Measured along lead at distances equal to or greater than 1/32" from seating plane.

^c Pulse duration = 50 μ seconds, duty factor ≤ 0.02 .

^d See accompanying *Turn-On and Turn-Off-Time-Measurement Circuit*.

^e See accompanying *Storage-Time-Measurement Circuit*.

OPERATING CONSIDERATIONS

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

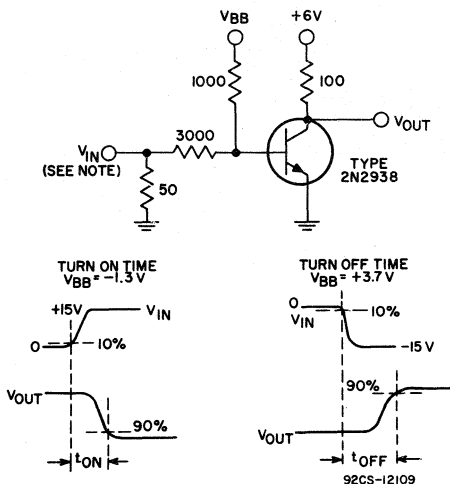
The *Leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.



2N2938

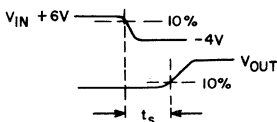
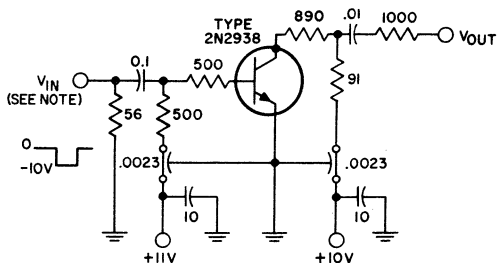
TURN-ON AND TURN-OFF-TIME MEASUREMENT CIRCUIT AND ASSOCIATED WAVE FORMS



RESISTANCE VALUES ARE IN OHMS

NOTE: V_{IN} RISE TIME ≤ 1 NANOSECOND, PULSE WIDTH ≥ 300 NANOSECONDS, DUTY FACTOR ≤ 0.02 .

STORAGE-TIME MEASUREMENT CIRCUIT AND ASSOCIATED WAVE FORMS



92CS-12113

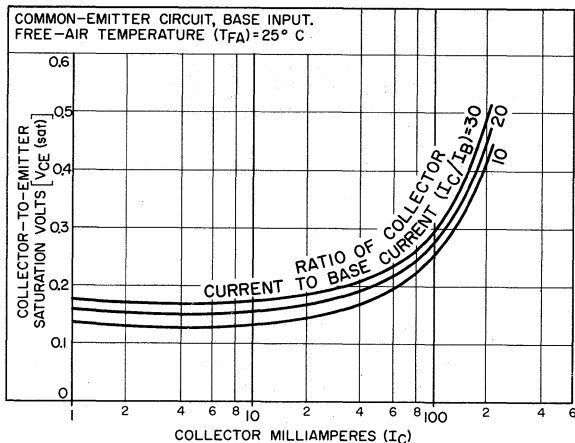
RESISTANCE VALUES ARE IN OHMS

CAPACITANCE VALUES ARE IN μF

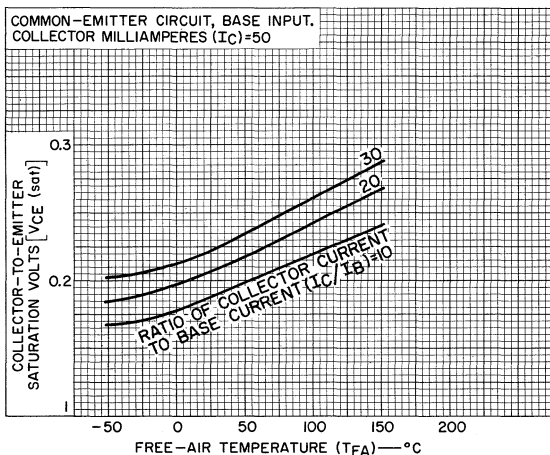
NOTE: V_{IN} RISE TIME ≤ 1 NANOSECOND, PULSE WIDTH ≥ 300 NANOSECONDS, DUTY FACTOR ≤ 0.02 .



TYPICAL COLLECTOR-TO-EMITTER SATURATION-VOLTAGE CHARACTERISTICS



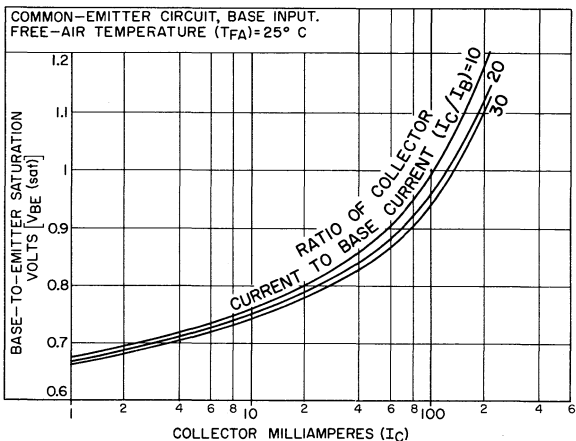
92CS-12128



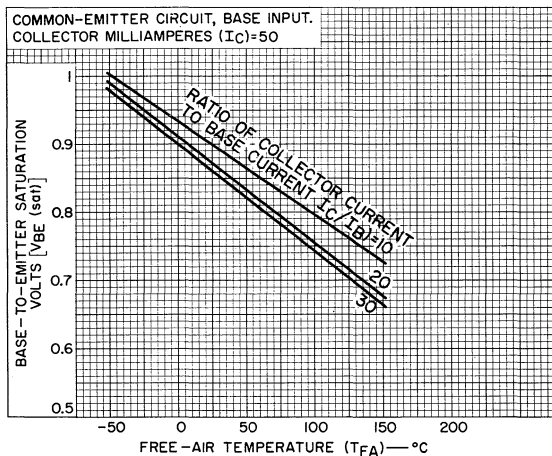
92CS-12118



TYPICAL BASE-TO-EMITTER SATURATION VOLTAGE CHARACTERISTICS



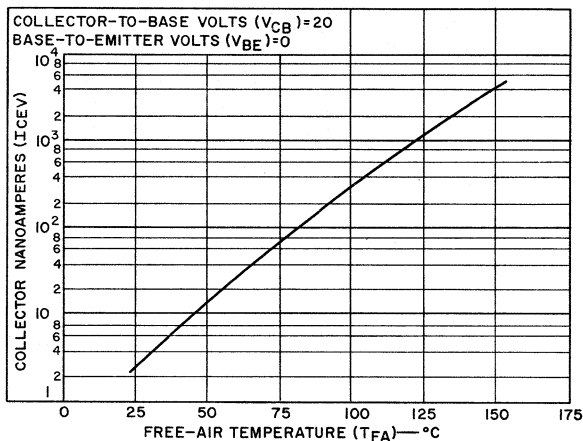
92CS-12127RI



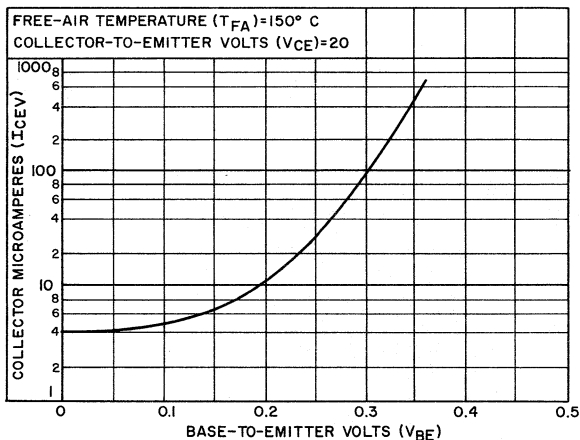
92CS-12117RI



TYPICAL COLLECTOR-CURRENT CHARACTERISTICS



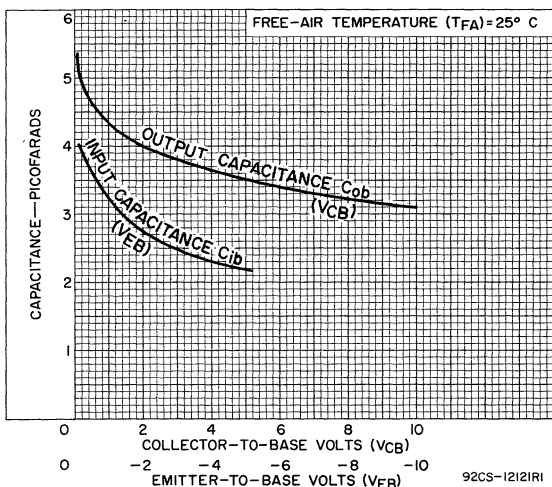
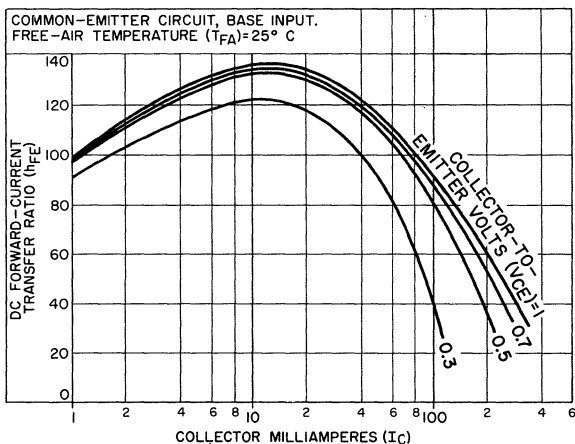
92CS-12125



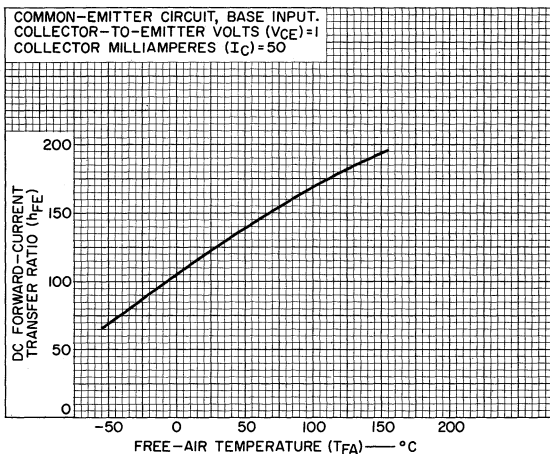
92CS-12126



TYPICAL CAPACITANCE CHARACTERISTICS

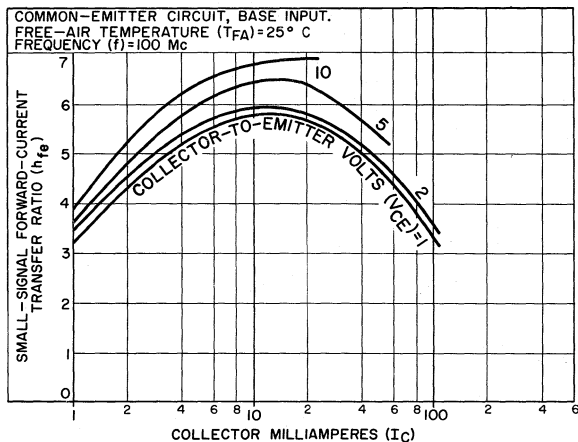
TYPICAL DC FORWARD-CURRENT
TRANSFER RATIO CHARACTERISTICS

TYPICAL DC FORWARD-CURRENT TRANSFER RATIO CHARACTERISTIC



92CS-12116

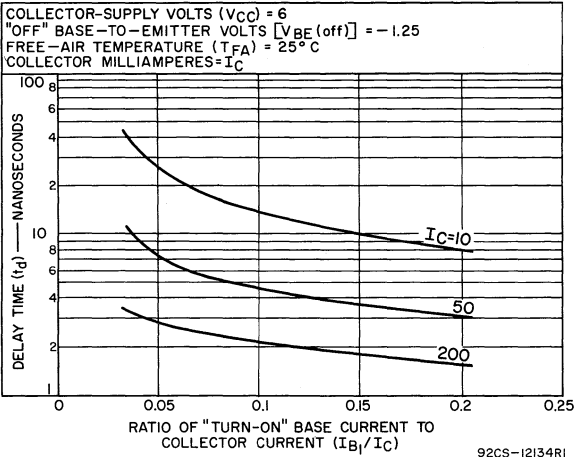
TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER RATIO CHARACTERISTICS



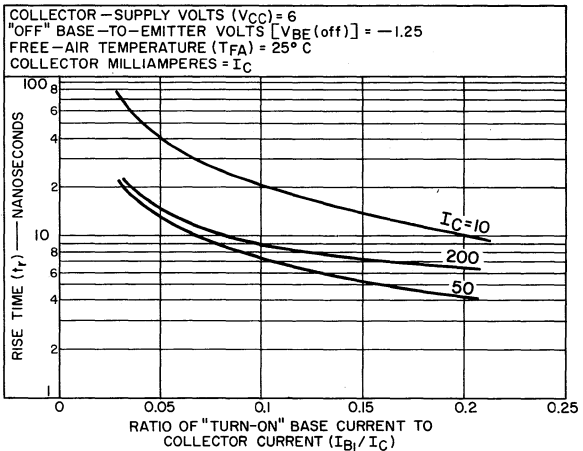
92CS-12130RI



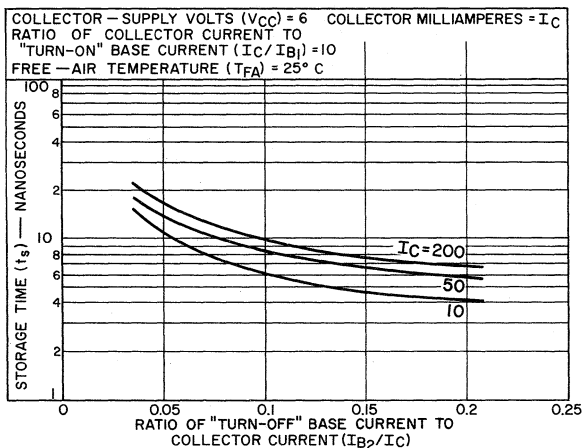
TYPICAL DELAY-TIME CHARACTERISTICS



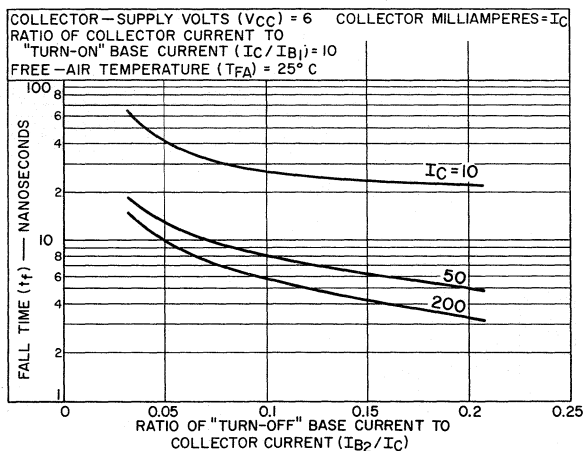
TYPICAL RISE-TIME CHARACTERISTICS



TYPICAL STORAGE-TIME CHARACTERISTICS



TYPICAL FALL-TIME CHARACTERISTICS



Transistor

GERMANIUM P-N-P ALLOY TYPE

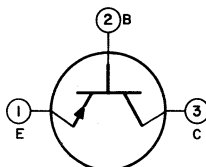
For Audio-Frequency-Driver Amplifier Applications
in Consumer-Product and Industrial Equipment

Mechanical:

Dimensions. See Outline T0-1 in General Section

Terminal Diagram: BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector

Maximum and Minimum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage:

With emitter open.	V_{CBO}	-30 max.	volts
With emitter-to-base reverse bias dc volts = -2	V_{CBV}	-30 max.	volts

Collector-to-Emitter Voltage:

With external base-to-emitter resistance (ohms) ≤ 10000	V_{CER}	-25 max.	volts
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Emitter-to-Base Voltage:

With collector open.	V_{EBO}	-25 max.	volts
------------------------------	-----------	----------	-------

Collector Current. I_C -150 max. ma

Emitter Current. I_E 150 max. ma

Transistor Dissipation:

At free-air temperatures:	P_T		
From -65° to 55° C		120 max.	mw
Above 55° C.		Derate linearly 2.6 mw/°C	

At case temperatures:

In infinite heat-sink—			
From -65° to 55° C		300 max.	mw
Above 55° C.		Derate linearly 6.67 mw/°C	

In practical heat-sink, thermal

resistance < 50° C/watt—			
From -65° to 55° C		225 max.	mw
Above 55° C.		Derate linearly 5 mw/°C	

Temperature:

Operating Range (Junction)	T_{opr}	-65 to 100	°C
Storage Range.	T_{stg}	-65 to 100	°C
Leads ^a (During soldering):			
For 10 seconds maximum	T_L	255 max.	°C



ELECTRICAL CHARACTERISTICS

Free-air temperature = 25° C

Min. Typ. Max.

DC Collector-to-Base Breakdown

Voltage for emitter-to-base
reverse bias dc volts = -2, dc
collector ma. = -0.05. . . . BV_{CBV}

-30 - - volts

DC Collector-to-Emitter Break-

down Voltage for external
base-to-emitter resistance
(ohms) = 10000, dc collector
ma. = -1 BV_{CER}

-25 - - volts

DC Emitter-to-Base Breakdown

Voltage for dc emitter ma. =
-0.05, collector current = 0. BV_{EBO}

-25 - - volts

DC Collector-Cutoff Current

for dc collector-to-base
volts = -20, emitter cur-
rent = 0 I_{CBO}

- - -5 μ a

DC Emitter-Cutoff Current for

dc emitter-to-base volts =
-20, collector current = 0. I_{EBO}

- - -7.5 μ a

Extrinsic Base-Lead Resistance

at 20 Mc for dc collector-to-
emitter volts = -10, dc col-
lector ma. = -10 r_{bb'}

- 300 - ohms

Collector-to-Base Feedback

Capacitance for dc collector-
to-emitter volts = -12, dc
collector ma. = -1 C_{b'c}

- 6.5 - pf

Small-Signal Short-Circuit

Forward-Current Transfer
Ratio at frequency (kc) = 1,
for dc collector-to-emitter
volts = -10, dc collector
ma. = -10. h_{fe}

200 350 -

Small-Signal Short-Circuit

Forward-Current Transfer
Ratio Cutoff Frequency for
dc collector-to-emitter
volts = -12, dc collector
ma. = -1 f_{hfb}

- 10 - Mc

^a Measured along lead at distances equal to or greater than 1/32" from seating plane.

OPERATING CONSIDERATIONS

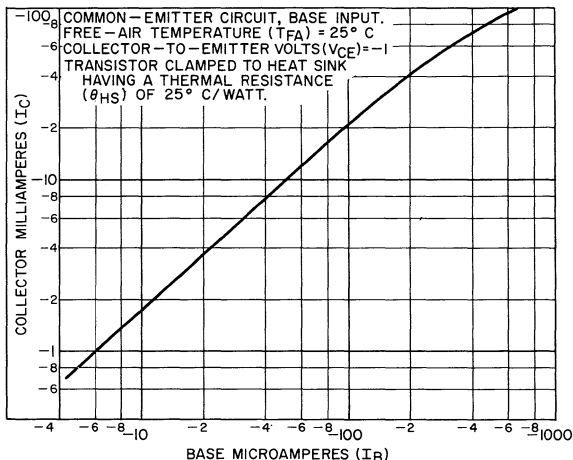
This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The flexible leads of this transistor are usually soldered



to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

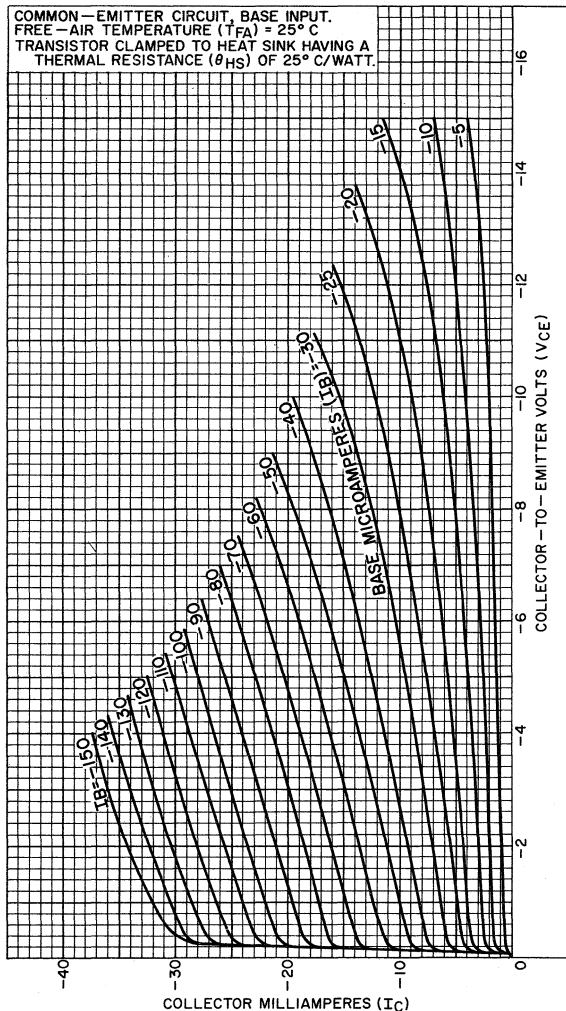
TYPICAL CURRENT-TRANSFER CHARACTERISTIC



92CS-12155

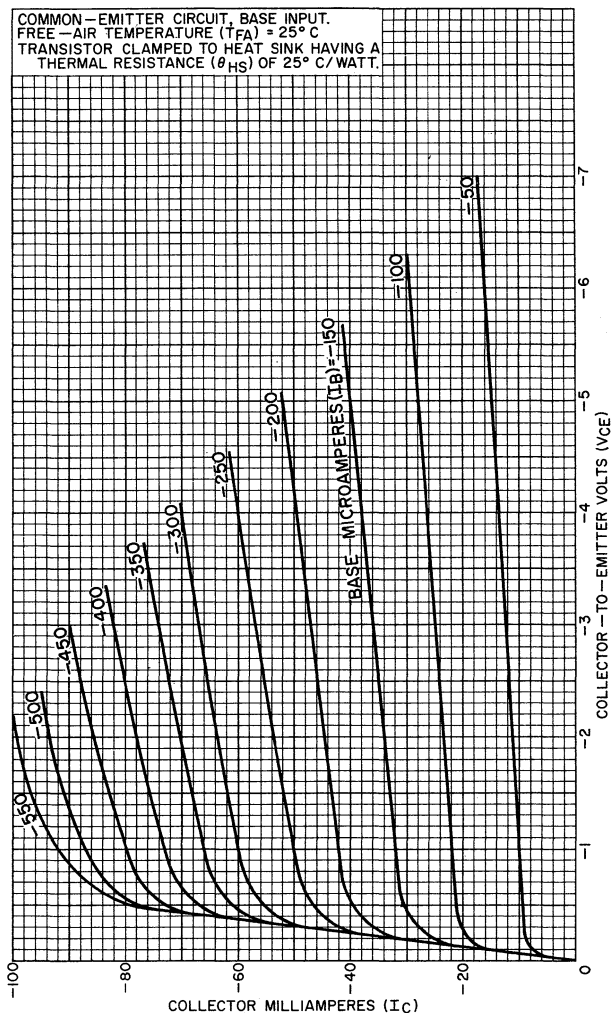


TYPICAL COLLECTOR CHARACTERISTICS



TYPICAL COLLECTOR CHARACTERISTICS

COMMON-EMITTER CIRCUIT, BASE INPUT.
 FREE-AIR TEMPERATURE (T_{FA}) = 25°C
 TRANSISTOR CLAMPED TO HEAT SINK HAVING A
 THERMAL RESISTANCE (θ_{HS}) OF 25° C/WATT.



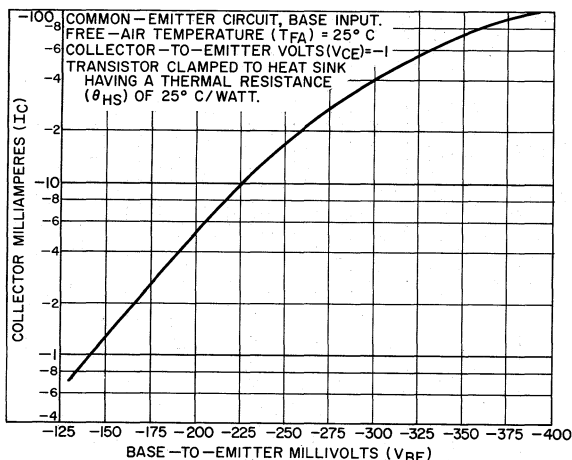
92CM-12145



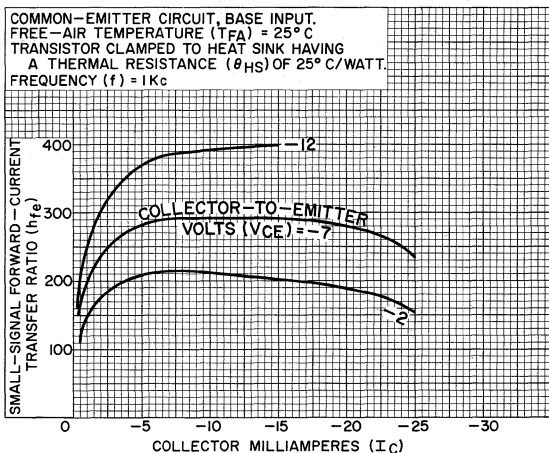
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DATA 3
 10-63

TYPICAL TRANSFER CHARACTERISTIC



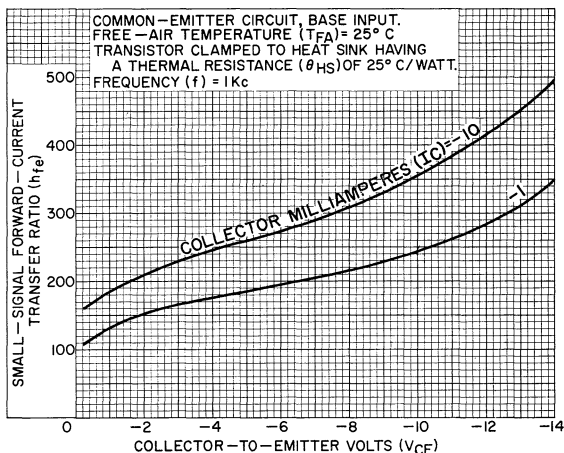
92CS-12147

TYPICAL SMALL-SIGNAL FORWARD-CURRENT
TRANSFER-RATIO CHARACTERISTICS

92CS-12142

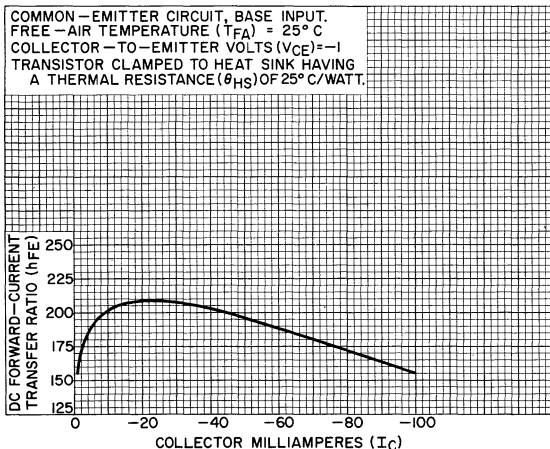


TYPICAL SMALL-SIGNAL FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTICS



92CS-12143

TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTIC



92CS-12146



Computer Transistor

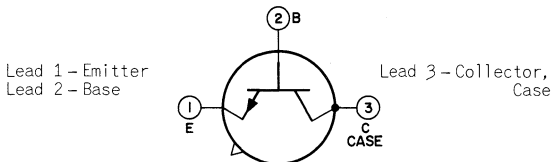
SILICON N-P-N EPITAXIAL-PLANAR TYPE

For High-Speed Switching Applications in Military and Commercial Digital Equipment

MECHANICAL

Dimensions See Outline TO-18 in General Section

TERMINAL DIAGRAM (Bottom View)



ABSOLUTE-MAXIMUM RATINGS

Collector-to-Base Voltage.	V_{CB0}	30	V
Collector-to-Emitter Voltage.	V_{CE0}	12	V
Emitter-to-Base Voltage.	V_{EB0}	5	V
Collector Current.	I_C	0.2	A

Transistor Dissipation

At case temperatures:^a

From -65 to 25°C	P_T	1.2	W
Above 25°C	Derate linearly	6.85 mW/°C	

At free-air temperatures:

From -65 to 25°C	P_T	0.36	W
Above 25°C	Derate linearly	2.06 mW/°C	

Temperature Range

Operating (Junction)	$T(\text{opr})$	-65 to 100	°C
Storage.	$T(\text{stg})$	-65 to 100	°C

Lead-Soldering Temperature ^b		300	°C
For 60 s max			

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode voltage and electrode-current values for given test conditions are dc at case temperature = 25°C

Collector-to-Base Breakdown Voltage	BV_{CB0}	30 min	V
$I_C = 0.01 \text{ mA}, I_E = 0$			
Collector-to-Emitter Breakdown Voltage	BV_{CES}	30 min	V
$I_C = 0.01 \text{ mA}, V_{EB} = 0$			
Emitter-to-Base Breakdown Voltage.	BV_{EB0}	5 min	V
$I_E = 0.1 \text{ mA}, I_C = 0$			
Collector-to-Emitter Sustaining Voltage ^c .	$V_{CE0}(\text{sus})$	12 min	V
$I_C = 10 \text{ mA}, I_B = 0$			



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DATA 1
2-66

Collector-to-Emitter Saturation Voltage

$I_C = 10 \text{ mA}, I_B = 1 \text{ mA}$	$V_{CE}(\text{sat})$	0.2 max	V
$I_C = 10 \text{ mA}, I_B = 1 \text{ mA}, T_A = 85^\circ\text{C}$	$V_{CE}(\text{sat})$	0.3 max	V
$I_C = 30 \text{ mA}, I_B = 3 \text{ mA}$	$V_{CE}(\text{sat})$	0.25 max	V
$I_C = 100 \text{ mA}, I_B = 10 \text{ mA}$	$V_{CE}(\text{sat})$	0.5 max	V

Base-to-Emitter Saturation Voltage

$I_C = 10 \text{ mA}, I_B = 1 \text{ mA}$	$V_{BE}(\text{sat})$	{ 0.72 min 0.87 max	V
$I_C = 30 \text{ mA}, I_B = 3 \text{ mA}$	$V_{BE}(\text{sat})$	1.15 max	V
$I_C = 100 \text{ mA}, I_B = 10 \text{ mA}$	$V_{BE}(\text{sat})$	1.6 max	V

Collector-Cutoff Current

$V_{CE} = 20 \text{ V}, R_{BE} = 0$	I_{CES}	0.4 max	μA
$V_{CE} = 20 \text{ V}, V_{EB} = 0, T_A = 85^\circ\text{C}$	I_{CES}	10 max	μA

DC Forward Current-Transfer Ratio^b

$V_{CE} = 0.35 \text{ V}, I_C = 10 \text{ mA}$	h_{FE}	{ 30 min 120 max	
$V_{CE} = 0.4 \text{ V}, I_C = 30 \text{ mA}$	h_{FE}	25 min	
$V_{CE} = 1 \text{ V}, I_C = 100 \text{ mA}$	h_{FE}	12 min	

Small-Signal Forward Current-Transfer Ratio

$f = 100 \text{ Mc/s}, V_{CE} = 10 \text{ V}, I_C = 10 \text{ mA}$	h_{fe}	4 min	
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Output Capacitance

$f = 0.14 \text{ Mc/s}, V_{CB} = 5 \text{ V}, I_E = 0$	C_{obo}	4 max	pF
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Storage Time

$V_{CC} = 10 \text{ V}, I_C = 10 \text{ mA}, I_{B1} = 10 \text{ mA}, I_{B2} = -10 \text{ mA}$	t_s	13 max	ns
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Turn-Off Time ($t_s + t_f$)

$V_{CC} = 2 \text{ V}, I_C = 30 \text{ mA}, I_{B1} = 3 \text{ mA}, I_{B2} = -3 \text{ mA}$	t_{off}	20 max	ns
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Turn-On Time ($t_d + t_r$)

$V_{CC} = 2 \text{ V}, I_C = 30 \text{ mA}, I_{B1} = 3 \text{ mA}, V_{BE}(\text{off}) = 0$	t_{on}	15 max	ns
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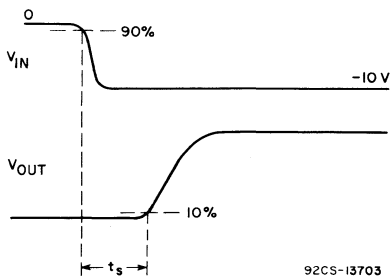
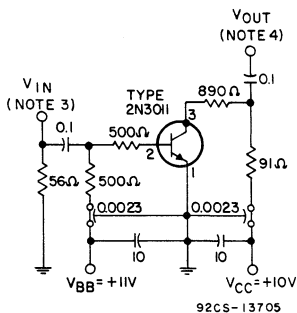
^a Measured at center of seating surface.

^b Measured along lead of distances $\geq 1/16$ inch from seating surface.

^c Pulse duration = 300 μs ; duty factor ≤ 0.02 .



STORAGE TIME TEST CIRCUIT AND WAVEFORMS



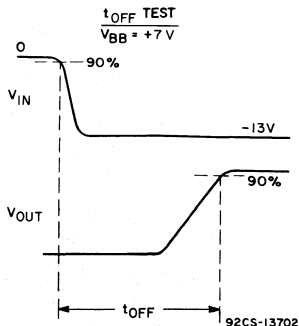
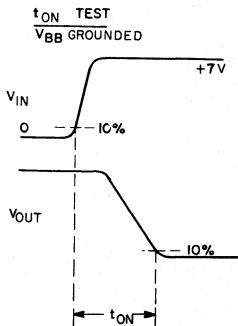
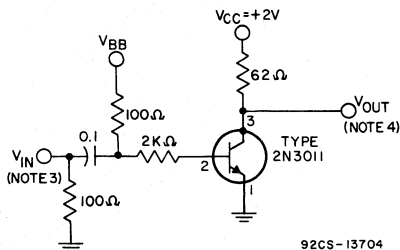
See reverse side for Notes.



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DATA 2
2-66

SWITCHING TIME TEST CIRCUIT AND WAVEFORMS



Note 1: All resistance values have ± 1 per cent tolerance; all capacitance values are in μF .

Note 2: With certain types of power supplies, it may be necessary to connect 25- μF decoupling capacitors across the power-supply terminals for V_{CC} and V_{BB} .

Note 3: Input voltage (V_{IN}) obtained from mercury-relay type pulse generator having an output impedance of 50 ohms. V_{IN} rise time < 1 ns; pulse duration > 200 ns; and duty factor < 0.02 .

Note 4: Input and output waveforms monitored by means of a sampling oscilloscope having a rise time < 1 ns and with a probe having a series resistance of ≥ 100 k Ω shunted by capacitance of < 2.5 pF.



2N3053/40053

Power Transistor

SILICON N-P-N TRIPLE-DIFFUSED PLANAR TYPE

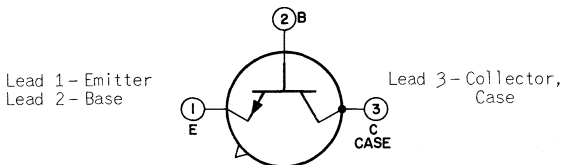
For a Wide Variety of Small-Signal, Medium Power Applications (Up to 20 Mc) in Commercial and Industrial Equipment

Mechanical:

Dimensions. See Outline TO-5 in General Section

Terminal Diagram

BOTTOM VIEW



Maximum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage V_{CBO} 60 max. volts
With emitter open

Collector-to-Emitter Voltage
With base-to-emitter reverse
bias dc volts = -1.5. V_{CEV} 60 max. volts

With external base-to-emitter
resistance (ohms) = 10. V_{CER} 50 max. volts

With base open
(Sustaining voltage). $V_{CEO(sus)}$ 40 max. volts

Emitter-to-Base Voltage V_{EBO} 5 max. volts
With collector open

Collector Current I_C 0.7 max. amp

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C. P_T 5 max. watts

Above 25° C. Derate linearly 0.0286 watt/°C

At free-air temperatures:

From -65° to 25° C. P_T 1 max. watt

Above 25° C. Derate linearly 0.00572 watt/°C

Temperature

Operating range T_{opr} -65 to 200 °C

Storage range T_{stg} -65 to 200 °C

Leads:^b

For 10 seconds maximum. T_L 255 max. °C

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C

Min. Max.

DC Collector-to-Base Breakdown

Voltage BV_{CBO} 60 - volts

$I_C = 0.1$ ma., $I_E = 0$



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DATA 1
3-64

2N3053/40053

Min. Max.

DC Collector-to-Emitter

Sustaining Voltage

I_C (Pulsed) = 100 ma.^c

$R_{BE} = 10$ ohms $V_{CER(sus)}$ 50 - volts

$I_B = 0$ $V_{CEO(sus)}$ 40 - volts

DC Base-to-Emitter

Saturation Voltage $V_{BE(sat)}$ - 1.7 volts

$I_C = 150$ ma., $I_B = 15$ ma.

DC Collector-to-Emitter

Saturation Voltage $V_{CE(sat)}$ - 1.4 volts

$I_C = 150$ ma., $I_B = 15$ ma.

DC Collector-Cutoff

Current I_{CBO} - 0.25 μ a

$V_{CB} = 30$ volts, $I_E = 0$

DC Emitter-Cutoff Current

I_{EBO} - 0.25 μ a

$V_{EB} = 4$ volts, $I_C = 0$

Input Capacitance

C_{ib} - 80 pf

$V_{EB} = 0.5$ volt, $I_C = 0$

Output Capacitance

C_{ob} - 15 pf

$V_{CB} = 10$ volts, $I_E = 0$

DC Forward-Current

Transfer Ratio h_{FE} 50 250

$V_{CE} = 10$ volts,

I_C (Pulsed) = 150 ma.^c

Small-Signal Short-Circuit

Forward-Current

Transfer Ratio h_{fe} 5 -

$f = 20$ Mc, $V_{CE} = 10$ volts,

$I_C = 50$ ma.

Thermal Resistance θ_{JC} - 35 $^{\circ}$ C/watt

Junction-to-case

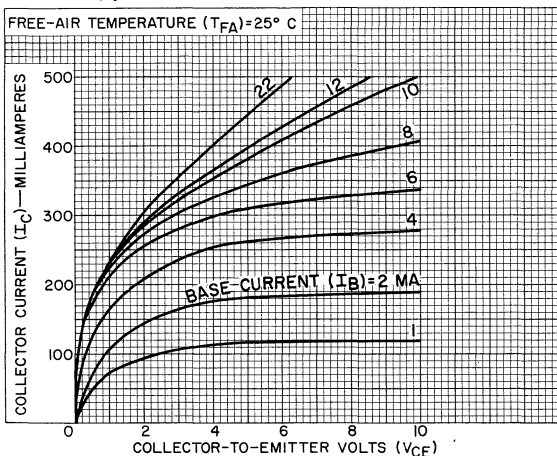
^a Measured at center of seating plane.

^b Measured 1/16" $\pm$ 1/32" along lead from seating plane.

^c Pulse duration = 300 μ seconds, duty factor = 0.018.

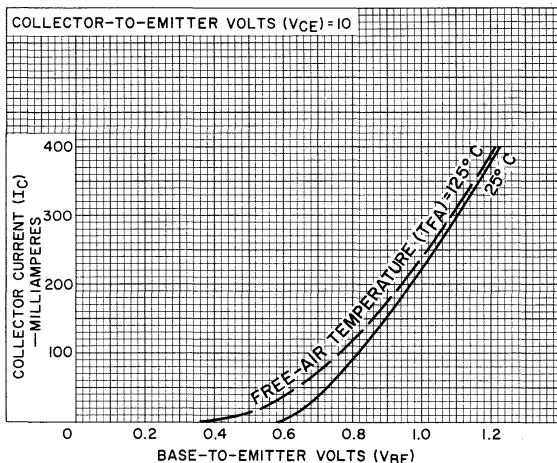


Typical Collector Characteristics



92CS-12327

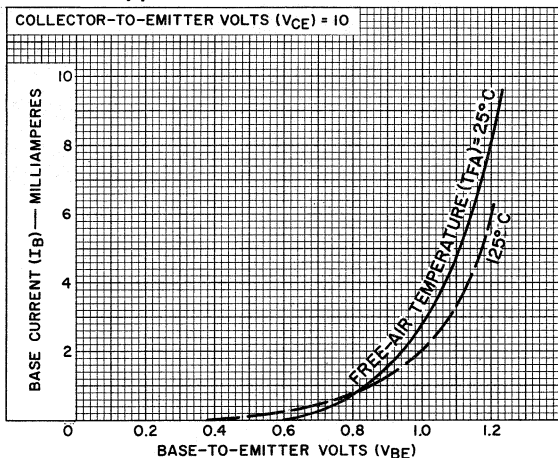
Typical Transfer Characteristics



92CS-12328

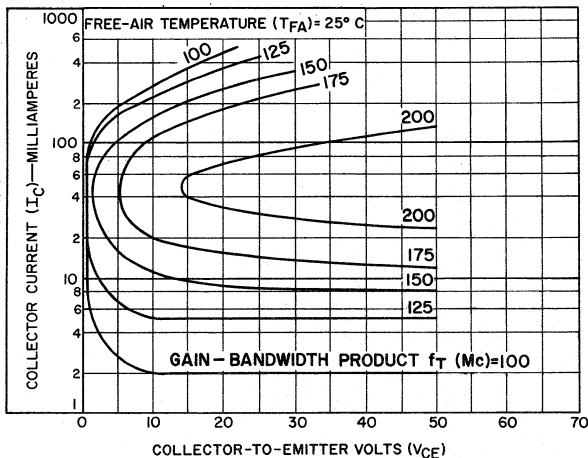


Typical Base Characteristics



92CS-12329

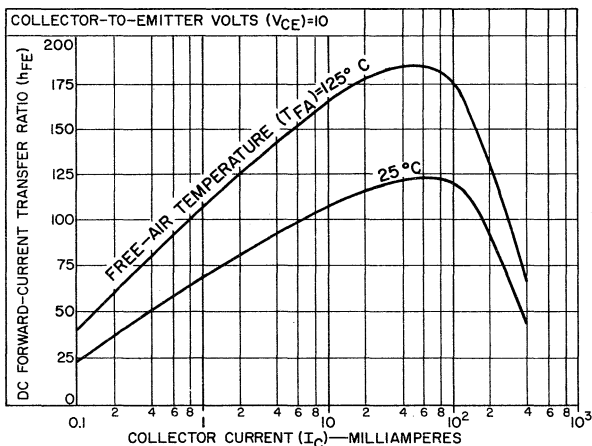
Typical Gain-Bandwidth-Product Characteristics



92CS-12335

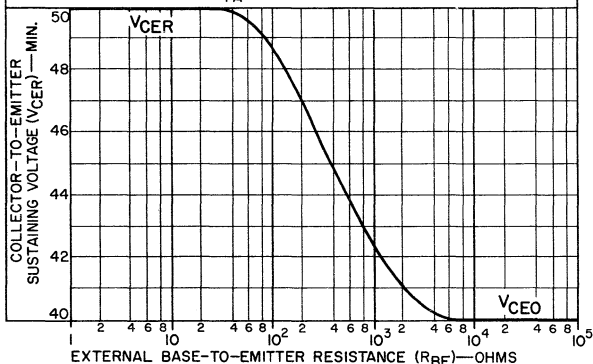
2N3053/40053

Typical DC Forward-Current Transfer Ratio Characteristics



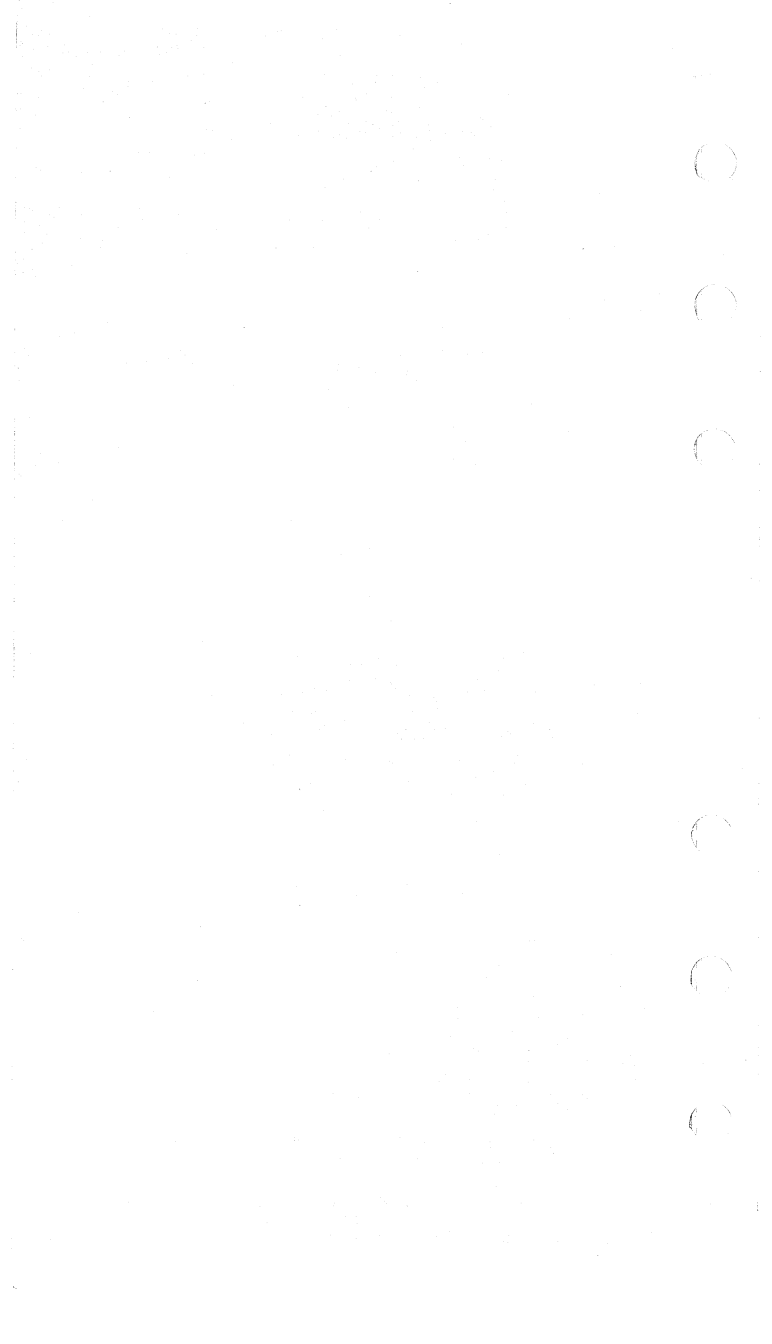
Typical Collector-to-Emitter Voltage Characteristics

V_{CER} =COLLECTOR-TO-EMITTER VOLTAGE WITH EXTERNAL RESISTANCE BETWEEN BASE AND EMITTER
 V_{CEO} =COLLECTOR-TO-EMITTER VOLTAGE WITH BASE OPEN
 FREE-AIR TEMPERATURE (T_{FA})=25° C



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DATA 3
 3-64



Power Transistor

SILICON N-P-N DIFFUSED TYPE
SMALL "TO-3" TYPE PACKAGE

For Power-Switching, Series- and Shunt-Regulator
Driver and Output Stages, and High-Fidelity Amplifier
Applications in Commercial and Industrial Equipment

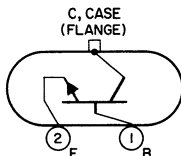
Mechanical:

Dimensions. See accompanying *Dimensional Outline*

Terminal Diagram

BOTTOM VIEW

Pin 1—Base
Pin 2—Emitter



Mounting Flange—
Collector,
Case

Maximum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage. V_{CBO} 90 max. volts
With emitter open

Collector-to-Emitter Voltage

With base-to-emitter reverse

bias dc volts = -1.5 V_{CEV} 90 max. volts

With external base-to-emitter

resistance (ohms) ± 100 V_{CER} 60 max. volts

With base open (Sus-

taining voltage) $V_{CEO(sus)}$ 55 max. volts

Emitter-to-Base Voltage. V_{EBO} 7 max. volts

With collector open

Collector Current. I_C 4 max. amp

Base Current I_B 2 max. amp

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C P_T 25 max. watts

Above 25° C. Derate linearly 0.143 watt/°C

Temperature

Operating range. T_{opr} -65 to 200 °C

Storage range. T_{stg} -65 to 200 °C

Pins:^b

For 10 seconds maximum T_P 235 max. °C



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DATA 1
3-64

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C

Min. Max.

DC Collector-to-Emitter

Sustaining Voltage

$I_C = 100 \text{ ma.}, R_{BE} = 100 \text{ ohms.}$	$V_{CER(sus)}$	60	-	volts
$I_C = 100 \text{ ma.}, I_B = 0.$	$V_{CEO(sus)}$	55	-	volts

DC Base-to-Emitter

Voltage	V_{BE}	-	1.7	volts
$V_{CE} = 4 \text{ volts}, I_C = 500 \text{ ma.}$				

DC Collector-to-Emitter

Saturation Voltage	$V_{CE(sat)}$	-	1	volt
$I_C = 500 \text{ ma.}, I_B = 50 \text{ ma.}$				

DC Collector Current

	I_{CEV}	-	1	ma
$V_{CE} = 90 \text{ volts}, V_{BE} = -1.5 \text{ volts}$				

DC Emitter-Cutoff Current

	I_{EBO}	-	1	ma
$V_{EB} = 7 \text{ volts}, I_C = 0$				

DC Forward-Current

Transfer Ratio	h_{FE}	25	100	
$V_{CE} = 4 \text{ volts}, I_C = 500 \text{ ma.}$				

Thermal Resistance

	θ_{JC}	-	7	°C/watt
Junction-to-case				

^a Measured at center of seating plane.

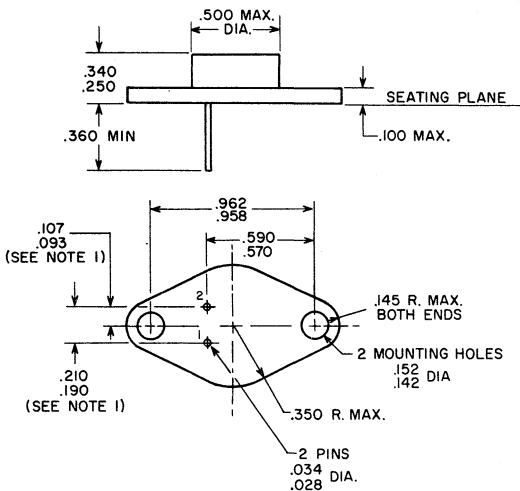
^b Measured 1/16" ± 1/32" along lead from seating plane.

OPERATING CONSIDERATIONS

It is important that the mounting flange which serves as the collector terminal be securely fastened to a heat sink.

In applications where the chassis is connected to the positive terminal of the voltage supply, it will be necessary to use an anodized-aluminum insulator having high thermal conductivity, or a 0.002" mica insulator between the mounting flange and the chassis. The insulator should extend beyond the mounting-flange. An aluminum washer should be drilled or punched to provide the two mounting holes, and the clearance holes for the emitter and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolt and the chassis, it is important that a fiber washer be used between the bolt and the chassis. See *Suggested Mounting Arrangement*.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard, when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

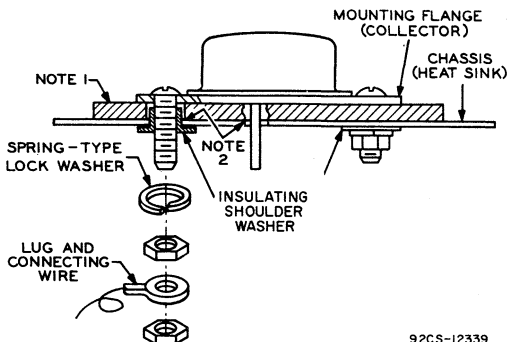


92CS-12337

DIMENSIONS IN INCHES

Note 1: These dimensions should be measured at points .050 to .055 below seating plane. When gauge is not used, measurement will be made at seating plane.

SUGGESTED MOUNTING ARRANGEMENT



92CS-12339

Note 1: 0.002" mica insulator or anodized aluminum insulator (drilled or punched with burrs removed).

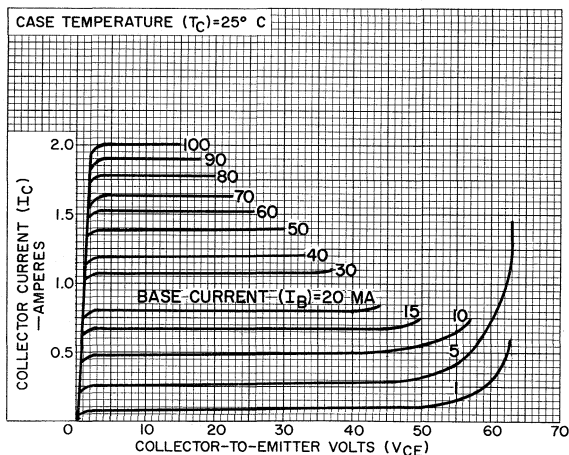
Note 2: Remove burrs from chassis holes.



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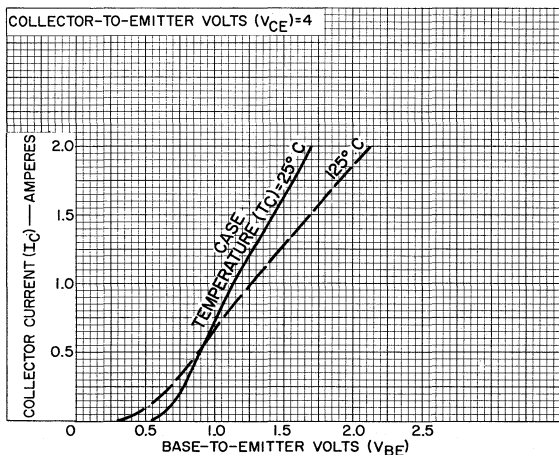
DATA 2
3-64

Typical Collector Characteristics



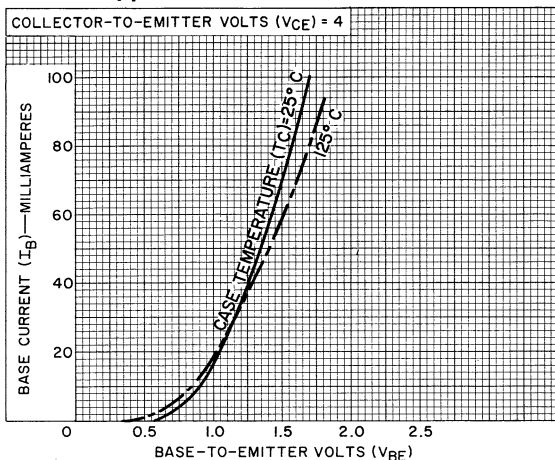
92CS-12303

Typical Transfer Characteristics



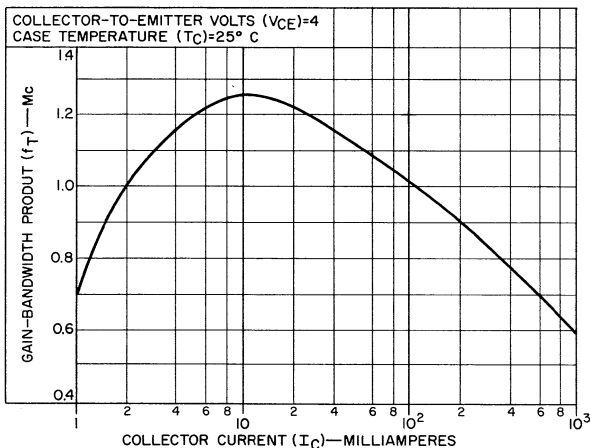
92CS-12325

Typical Base Characteristics



92CS-12305

Typical Gain-Bandwidth-Product Characteristic



92CS-12341

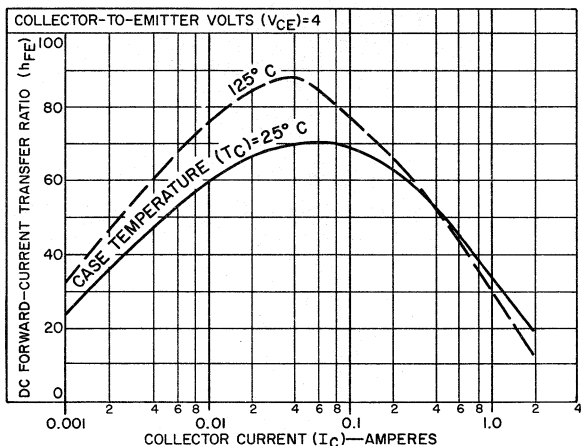


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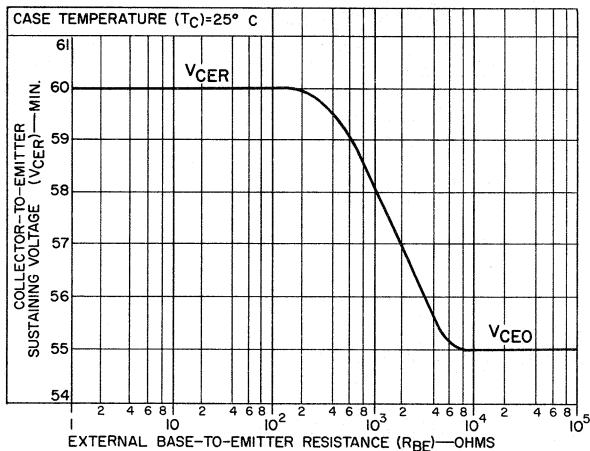
DATA 3
3-64

Typical DC Forward-Current Transfer-Ratio Characteristics



92CS-12302

Typical Collector-to-Emitter Voltage Characteristics



92CS-12322R1

Power Transistor

SILICON N-P-N DIFFUSED TYPE

For Power-Switching, Series- and Shunt-Regulator
Driver and Output Stages, and High Fidelity Amplifier
Applications in Commercial and Industrial Equipment

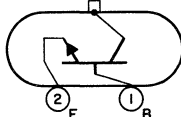
Mechanical:

Dimensions. See Outline TO-3 in General Section

Terminal Diagram

BOTTOM VIEW
C, CASE
(FLANGE)

Pin 1-Base
Pin 2-Emitter



MOUNTING FLANGE-
Collector,
Case

Maximum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage. V_{CBO} 100 max. volts
With emitter open

Collector-to-Emitter Voltage

With base-to-emitter reverse

bias dc volts = -1.5 V_{CEV} 100 max. volts

With external base-to-emitter

resistance (ohms) = 100. V_{CER} 70 max. volts

With base open

(Sustaining voltage) $V_{CEO(sus)}$ 60 max. volts

Emitter-to-Base Voltage. V_{EBO} 7 max. volts
With collector open

Collector Current. I_C 15 max. amp

Base Current I_B 7 max. amp

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C P_T 115 max. watts

Above 25° C. Derate linearly 0.657 watt/°C

Temperature

Operating range. T_{opr} -65 to 200 °C

Storage range. T_{stg} -65 to 200 °C

Pins:^b

For 10 seconds maximum T_p 235 max. °C

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C

Min. Max.

DC Collector-to-Emitter

Sustaining Voltage

$I_C = 200$ ma., $R_{BE} = 100$ ohms . $V_{CER(sus)}$ 70 - volts

$I_C = 200$ ma., $I_B = 0$ $V_{CEO(sus)}$ 60 - volts



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DATA 1
3-64

Min. Max.

DC Base-to-Emitter Voltage.	V_{BE}	-	1.8	volts
$V_{CE} = 4$ volts, $I_C = 4$ amperes				
DC Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	-	1.1	volts
$I_C = 4$ amperes, $I_B = 400$ ma.				
DC Collector Current	I_{CEV}	-	5	ma
$V_{CE} = 100$ volts, $V_{BE} = -1.5$ volts				
DC Emitter-Cutoff Current. . .	I_{EBO}	-	5	ma
$V_{EB} = 7$ volts, $I_C = 0$				
DC Forward-Current Transfer Ratio	h_{FE}	20	70	
$V_{CE} = 4$ volts, $I_C = 4$ amperes				
Thermal Resistance	θ_{JC}	-	1.5	$^{\circ}\text{C}/\text{watt}$
Junction-to-case				

^a Measured at center of seating plane.

^b Measured $1/16" \pm 1/32"$ along lead from seating plane.

OPERATING CONSIDERATIONS

It is important that the mounting flange which serves as the collector terminal be securely fastened to a heat sink.

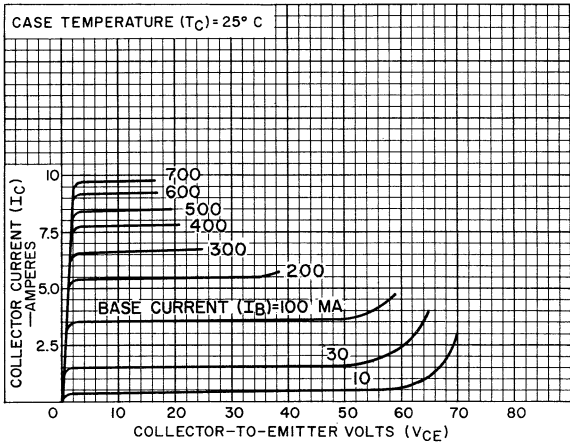
In applications where the chassis is connected to the positive terminal of the voltage supply, it will be necessary to use an anodized-aluminum insulator having high thermal conductivity, or a 0.002" mica insulator between the mounting flange and the chassis. The insulator should extend beyond the mounting-flange. An aluminum washer should be drilled or punched to provide the two mounting holes, and the clearance holes for the emitter and base pins. The burrs should then be removed from the washer and the washer finally anodized. To insure that the anodized insulating layer is not destroyed during mounting, it will also be necessary to remove the burrs from the holes in the chassis. Furthermore, to prevent a short circuit between the mounting bolt and the chassis, it is important that a fiber washer be used between the bolt and the chassis. See *Suggested Mounting Arrangement*.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard, when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

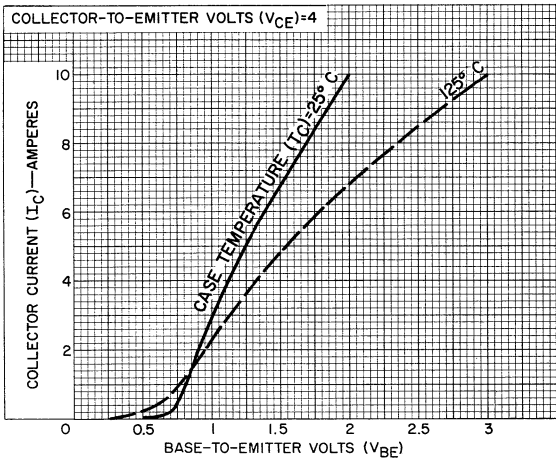
SUGGESTED MOUNTING ARRANGEMENT

shown under type 2N3054 also applies for the 2N3055

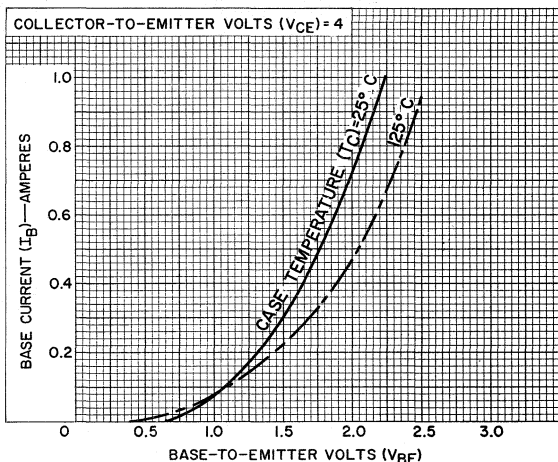
Typical Collector Characteristics



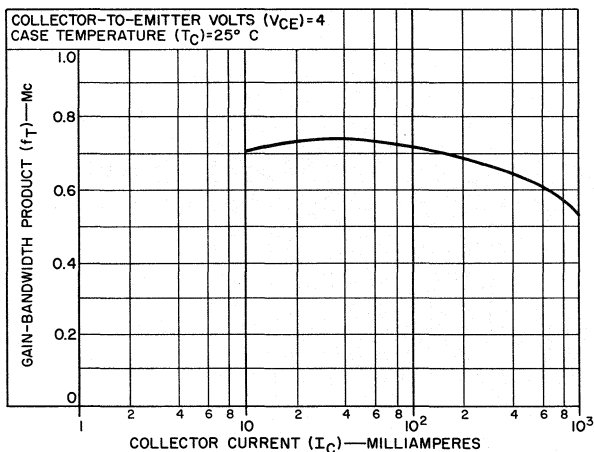
Typical Transfer Characteristics



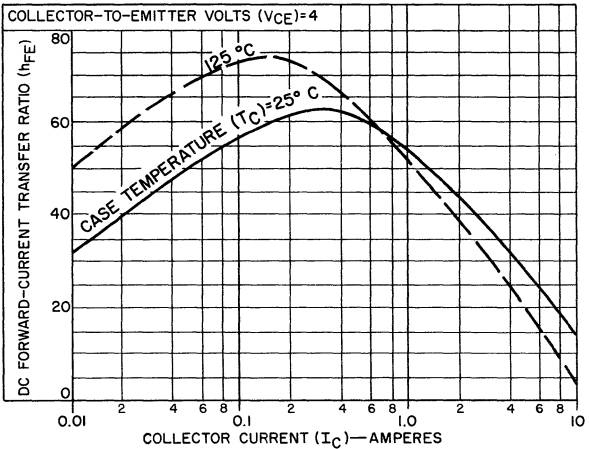
Typical Base Characteristics



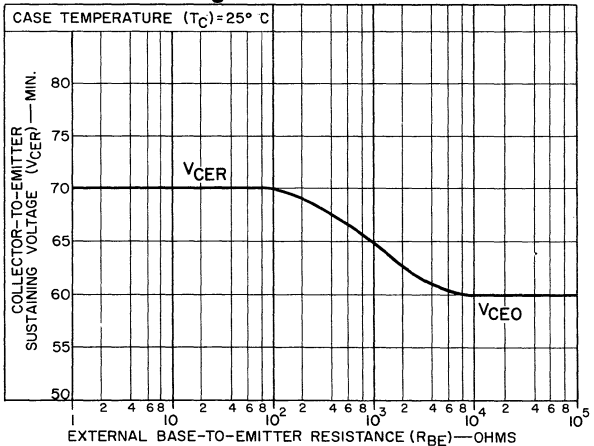
Typical Gain-Bandwidth-Product Characteristic

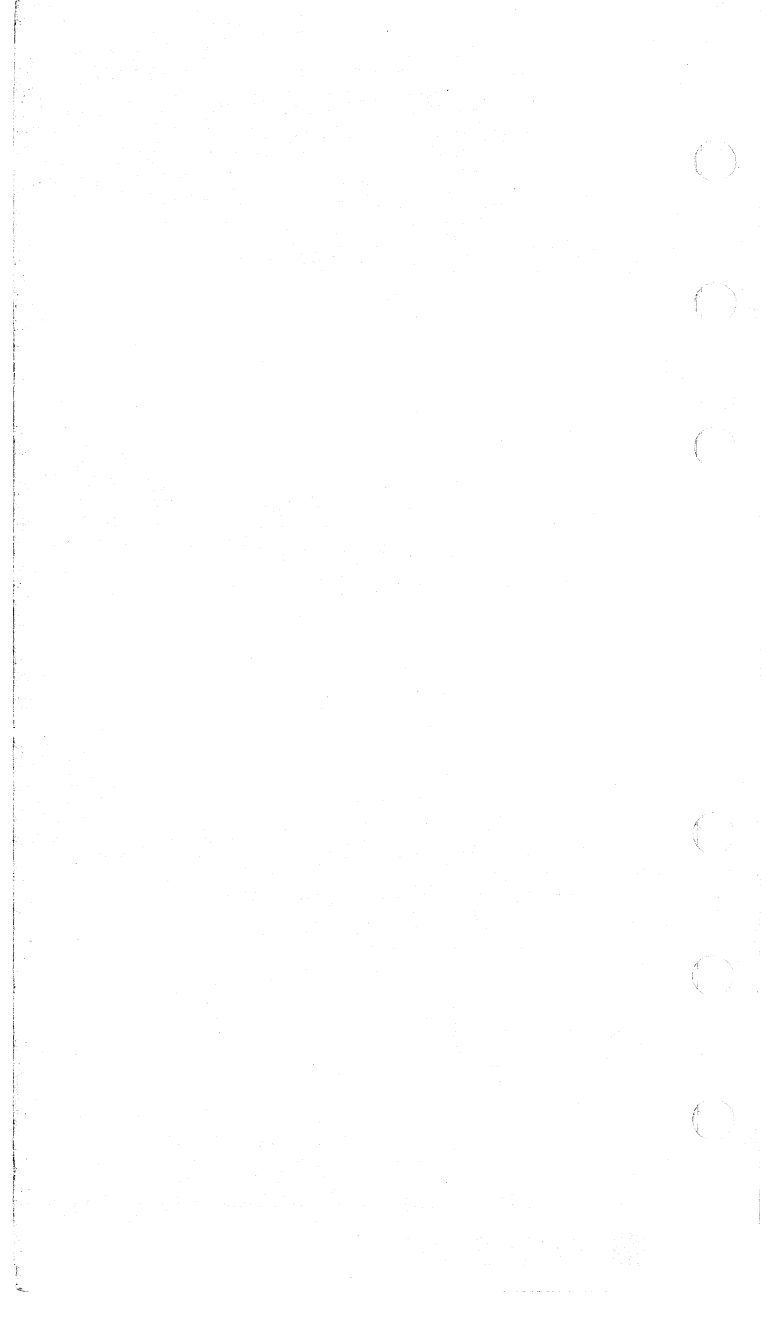


Typical DC Forward-Current Transfer-Ratio Characteristics



Typical Collector-to-Emitter Voltage Characteristics





Transistor

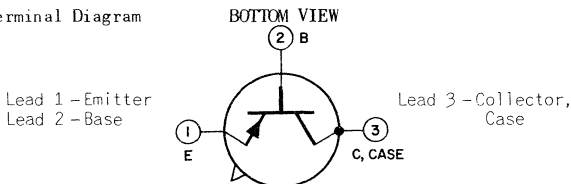
SILICON N-P-N TRIPLE-DIFFUSED PLANAR TYPE

For Large-Signal VHF Class C and Small-Signal VHF Class A Amplifier Applications in Industrial and Military Communications Equipment

Mechanical:

Dimensions. See Outline TO-5 in General Section

Terminal Diagram



Maximum and Minimum Ratings, Absolute-Maximum Values:

Collector-to-Emitter Voltage

With reverse bias

$V_{BE} = -1.5$ volts. . . . V_{CEX} 85 max. volts

With base open. V_{CEO} 60 max. volts

Emitter-to-Base Voltage . . . V_{EBO} 4 max. volts

With collector open

Collector Current I_C 0.5 max. amp

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C . . . P_T 4 max. watts

Above 25° C P_T Derate linearly 0.023 watt/ $^{\circ}$ C

At free-air temperatures:

From -65° C to 25° C . . . P_T 1 max. watt

Above 25° C P_T Derate linearly 0.006 watt/ $^{\circ}$ C

Temperature

Operating range (Junction) T_{opr} -65 to 200 $^{\circ}$ C

Storage range T_{stg} -65 to 200 $^{\circ}$ C

Leads:^b

For 10 seconds maximum. T_L 255 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C, unless otherwise specified

Min. Max.

DC Collector-to-Emitter Break-down Voltage

With reverse bias

$V_{BE} = -1.5$ volts, $I_C = 0.1$ ma. . BV_{CEX} 85 - volts

With base open (Sustaining voltage), pulsed

$I_C = 10$ ma.^c BV_{CEO} 60 - volts



		Min.	Max.	
DC Emitter-to-Base Break-down Voltage.	BV_{EBO}	4	-	volts
$I_E = 0.1$ ma., $I_C = 0$				
DC Collector-Cutoff Current				
$V_{CB} = 30$ volts, $I_E = 0$, $T_{FA} = 25^\circ$ C.	I_{CBO}	-	0.1	μ a
150 $^\circ$ C.	I_{CBO}	-	100	μ a
Real Part of Small-Signal Short-Circuit Input Impedance	$h_{ie}(\text{real})$	25	75	ohms
$f = 50$ Mc, $V_{CE} = 28$ volts, $I_C = 25$ ma.				
Real Part of Small-Signal Short-Circuit Output Impedance	$\frac{1}{Y_{22}(\text{real})}$	500	1000	ohms
$f = 50$ Mc, $V_{CE} = 28$ volts, $I_C = 25$ ma.				
Output Capacitance.	C_{ob}	-	6	pf
$f = 1$ Mc, $V_{CB} = 28$ volts, $I_C = 0$				
DC Forward-Current Transfer Ratio	h_{FE}	50	275	
$V_{CE} = 28$ volts, pulsed, $I_C = 25$ ma. ^c				
Small-Signal Short-Circuit Forward-Current Transfer Ratio	h_{fe}	5	-	
$f = 50$ Mc, $V_{CE} = 28$ volts, $I_C = 25$ ma.				
$r_{bb}' C_b' C_c$ Product	$r_{bb}' C_b' C_c$	-	60	psec
$f = 50$ Mc, $V_{CB} = 28$ volts, $I_C = 25$ ma.				
Power Gain ^d	G_{pe}	18	-	db
Class A Service, $f = 50$ Mc, $V_{CE} = 28$ volts, $I_C = 25$ ma., $P_o = 0.2$ watt (with heat sink)				
Power Output				
Class C Service (Oscillator), $V_{CE} = 28$ volts, $P_i = 0.1$ watt (with heat sink), $f =$				
50 Mc ^e	P_o	1	-	watt
150 Mc ^f	P_o	0.4	-	watt

^a Measured at center of seating plane.

^b Measured $1/16" \pm 1/32"$ along lead from seating plane.

^c Pulse duration of 300 μ seconds, duty factor < 0.018 .

^d See accompanying Power Gain Measurement Circuit for Class A Service.

^e See accompanying Power Output Measurement Circuit for Class C Service at 50 Mc.

^f See accompanying Power Output Measurement Circuit for Class C Service at 150 Mc.



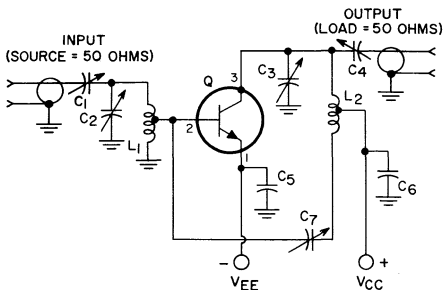
OPERATING CONSIDERATIONS

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the seating plane provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

POWER GAIN MEASUREMENT CIRCUIT, CLASS A SERVICE Neutralized, 50 Mc



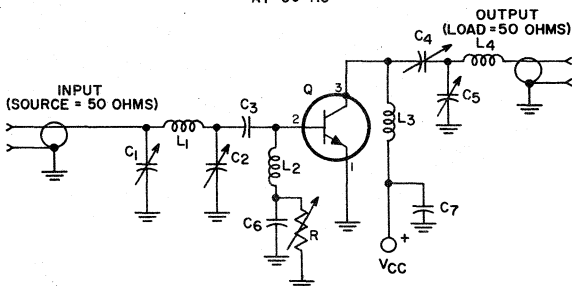
92CS-12270RI

- | | |
|----------------------------|--|
| C_1 : 7-100 pf | L_1 : 0.12 μ h, 3 turns, No.16 wire, |
| C_2 : 8-60 pf | 7/16" inside diameter X |
| C_3 : 14-150 pf | 1/4" long, tap at 1 turn |
| C_4 : 6-80 pf | from ground |
| C_5, C_6 : 0.005 μ f | L_2 : 0.23 μ h, 5 turns, No.16 wire, |
| C_7 : 0.9-7 pf | 7/16" inside diameter X |
| | 1/2" long, tap at 3 turns |
| | from collector terminal |
| | Q: Transistor type 2N3118 |



2N3118

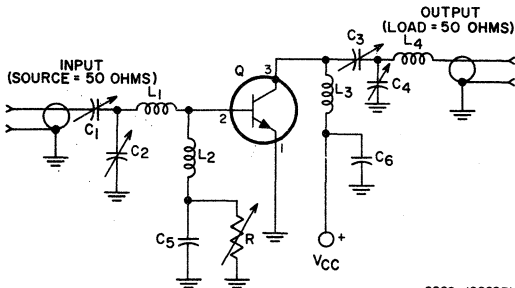
POWER OUTPUT MEASUREMENT CIRCUITS, CLASS C SERVICE AT 50 Mc



92CS-12268RI

- | | |
|----------------------------|--|
| C_1 : 70-350 pf | L_1 : 0.13 μ h, 4 turns, No.18 wire, |
| C_2, C_4, C_5 : 7-100 pf | 1/4" inside diameter |
| C_3 : 0.01 μ f | closely wound |
| C_6 : 0.002 μ f | L_2 : 2.4 μ h, choke, |
| C_7 : 0.02 μ f | Miller Part No.4606 |
| R : 100 ohms, | L_3 : 0.6 μ h, 10 turns, No.18 wire, |
| variable | 3/8" inside diameter |
| | closely wound |
| | L_4 : 0.6 μ h, 10 turns, No.18 wire, |
| | 3/8" inside diameter |
| | closely wound |
| | Q: Transistor type 2N3118 |

AT 150 Mc

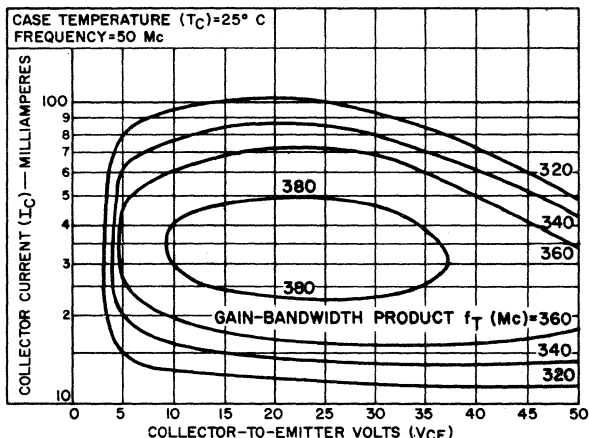


92CS-12269RI

C_1, C_2 : 1.5–20 pf
 C_3 : 4–40 pf
 C_4 : 7–100 pf
 C_5 : 1800 pf
 C_6 : 0.01 μ f
 R : 100 ohms,
 variable

L_1 : 0.1 μ h, 4 turns, No.18 wire,
 1/4" inside diameter
 closely wound
 L_2 : 750-ohm ferrite choke
 L_3 : 0.075 μ h, 4 turns, No.16 wire,
 1/4" inside diameter X
 3/8" long
 L_4 : 0.055 μ h, 3 turns, No.16 wire,
 1/4" inside diameter X
 1/4" long
 Q : Transistor type 2N3118

Typical Small-Signal Collector-Current Characteristics



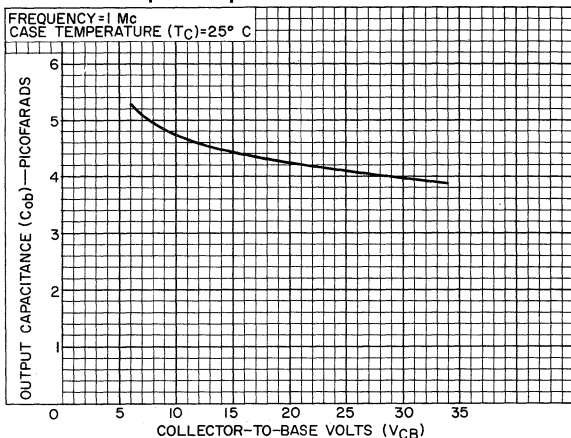
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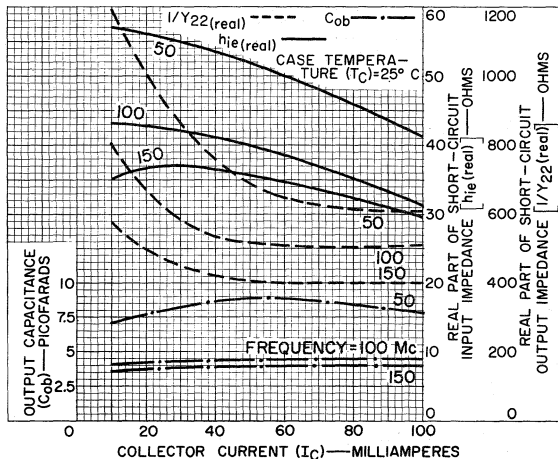
DATA 3
2-64

Typical Small-Signal Output-Capacitance Characteristic



92CS-12283

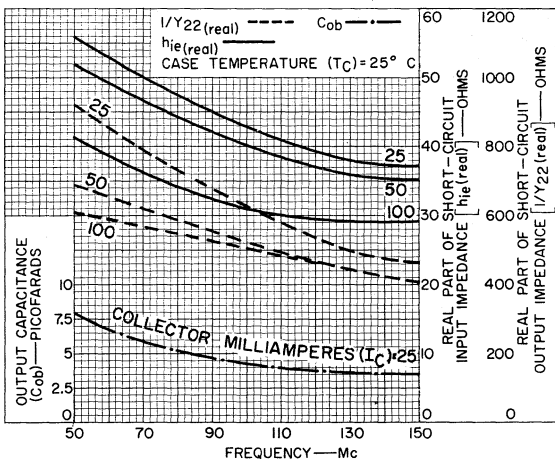
Typical Small-Signal Operation Characteristics



92CS-12289

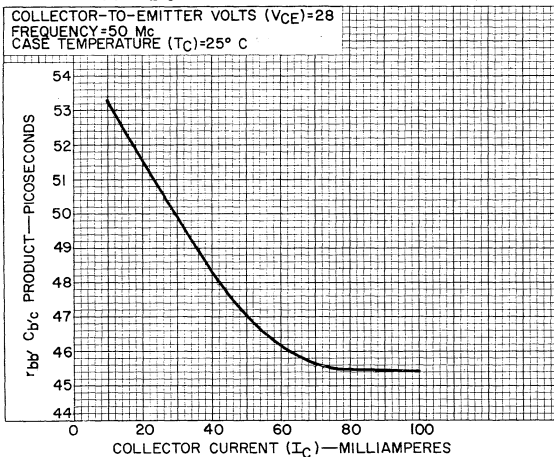


Typical Small-Signal Operation Characteristics



92CS-12288

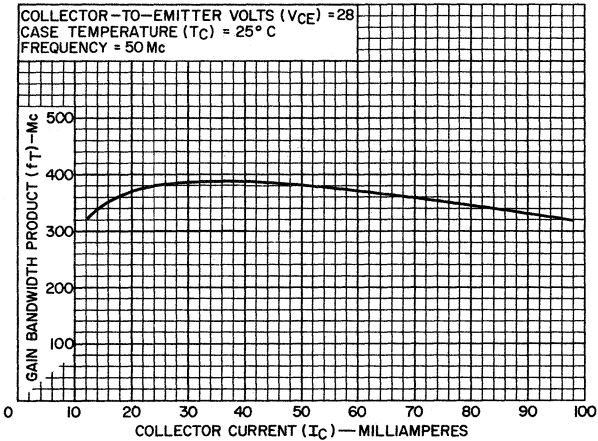
Typical Small-Signal $r_{bb'} C_{b'c}$ - Product Characteristic



92CS-12284

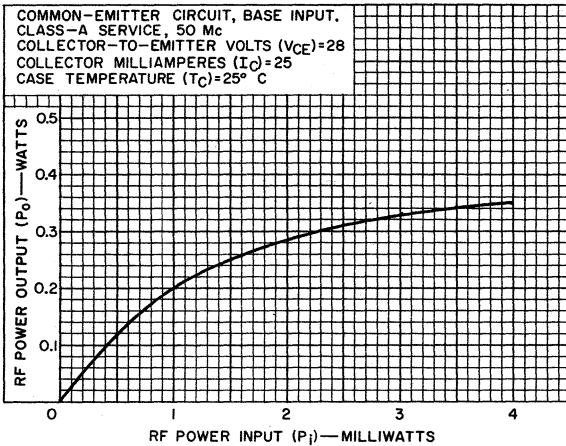


Typical Small-Signal Gain-Bandwidth Product Characteristic



92CS-12287

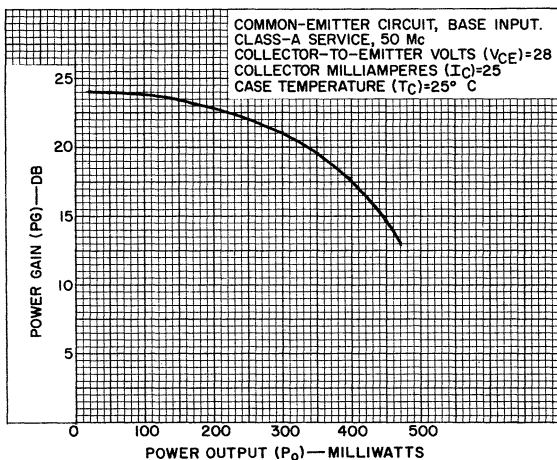
Typical Class-A RF Power Output Characteristic



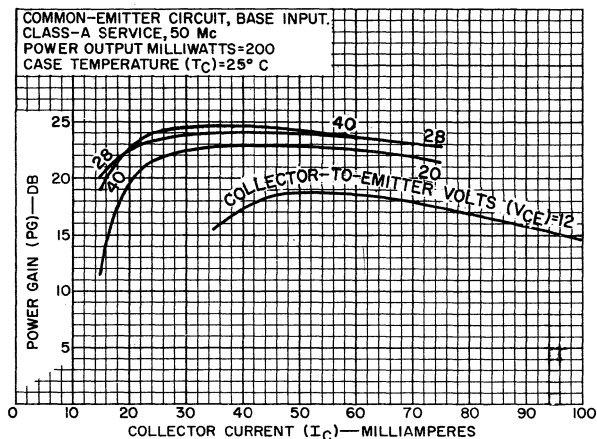
92CS-12278



Typical Class-A Power Gain Characteristics



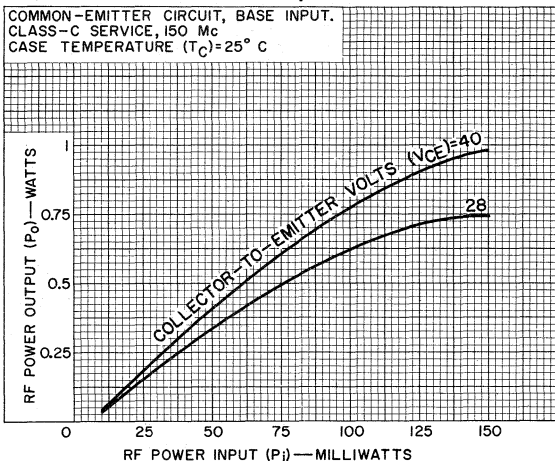
92CS-12277



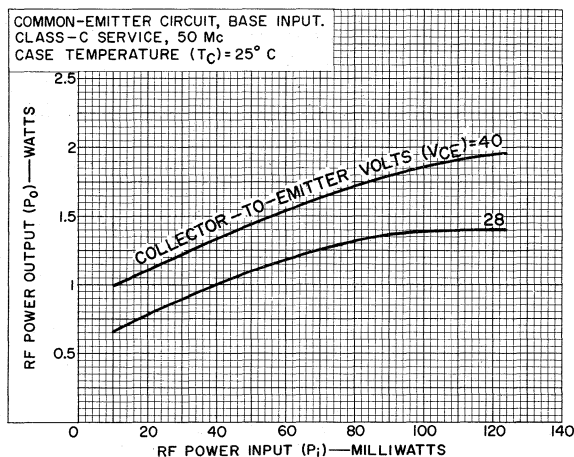
92CS-12276



Typical Large-Signal, Class C RF Power Output Characteristics



92CS-12273



92CS-12272



Transistor

SILICON N-P-N TRIPLE-DIFFUSED TYPE

For High-Voltage, High-Frequency Pulse-Amplifier and High-Voltage Saturated Switching Applications in Industrial and Military Equipment

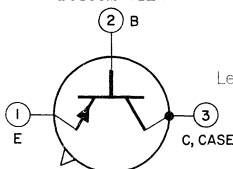
Mechanical:

Dimensions. See Outline TO-5 in General Section

Terminal Diagram

BOTTOM VIEW

Lead 1—Emitter
Lead 2—Base



Lead 3—Collector,
Case

Maximum and Minimum Ratings, *Absolute-Maximum Values:*

Collector-to-Base Voltage. V_{CBO} 100 max. volts
With emitter open

Collector-to-Emitter
Voltage

With reverse bias

$V_{EB} = 1.5$ volts. . . . V_{CEX} 100 max. volts

With base open V_{CEO} 80 max. volts

Emitter-to-Base Voltage. . V_{EBO} 4 max. volts
With collector open

Collector Current. I_C 0.5 max. amp

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C. . . P_T 4 max. watts

Above 25° C. P_T Derate linearly 0.023 watt/ $^{\circ}$ C

At free-air temperatures:

From -65° to 25° C. . . P_T 1 max. watt

Above 25° C. P_T Derate linearly 0.006 watt/ $^{\circ}$ C

Temperature

Operating range

(Junction) T_{opr} -65 to 200 $^{\circ}$ C

Storage range. T_{stg} -65 to 200 $^{\circ}$ C

Leads:^b

For 10 seconds

maximum. T_L 255 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C, unless otherwise specified
Min. Max.

DC Collector-to-Base Breakdown

Voltage. BV_{CBO} 100 - volts
 $I_C = 0.1$ ma., $I_E = 0$



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DATA 1
2-64

Min. Max.

DC Collector-to-Emitter

Breakdown Voltage

With reverse bias $V_{EB} = 1.5$
volts, $I_C = 0.1$ ma. . . .

BV_{CEX}

100

-

volts

With base open (Sustaining
voltage), pulsed

$I_C = 10$ ma.^c. $BV_{CEO(sus)}$

80

-

volts

DC Emitter-to-Base

Breakdown Voltage

BV_{EBO}

4

-

volts

$I_E = 0.1$ ma., $I_C = 0$

DC Base-to-Emitter

Saturation Voltage. $V_{BE(sat)}$

-

1.1

volts

$I_C = 100$ ma., $I_B = 10$ ma.

DC Collector-to-Emitter

Saturation Voltage. $V_{CE(sat)}$

-

0.5

volt

$I_C = 100$ ma., $I_B = 10$ ma.

DC Collector-Cutoff Current

$V_{CB} = 60$ volts, $I_E = 0$, $T_{FA} =$

25° C.

I_{CBO}

-

50

na

150° C.

I_{CBO}

-

50

μ a

DC Emitter-Cutoff Current . .

I_{EBO}

-

100

na

$V_{EB} = 3$ volts, $I_C = 0$,

$T_{FA} = 25^\circ$ C

Output Capacitance.

C_{ob}

-

6

pf

$f = 1$ Mc, $V_{CB} = 28$ volts,

$I_C = 0$

DC Forward-Current Transfer

Ratio

With $V_{CE} = 10$ volts,

$I_C = 10$ ma.

h_{FE}

40

-

With pulsed $V_{CE} = 10$ volts^c,

$I_C =$

100 ma.

h_{FE}

50

200

250 ma.

h_{FE}

20

-

Gain-Bandwidth Product. . . .

f_T

250

-

Mc

$f = 50$ Mc, $V_{CE} = 28$ volts,

$I_C = 25$ ma.

Pulse-Amplifier Rise Time^d. . $t_d + t_r$

-

20

nsec

$V_{CC} = 80$ volts, $I_C = 10$ ma.

Saturated Switch Turn-On

Time^e.

t_{on}

-

40

nsec

(delay time + rise time)

$V_{CC} = 28$ volts, $I_C =$

100 ma., $I_{B1} = 10$ ma.

Saturated Switch Turn-Off

Time^e.

t_{off}

-

700

nsec

(storage time + fall time)

$V_{CC} = 28$ volts, $I_C =$

100 ma., $I_{B2} = -10$ ma.



- a Measured at center of seating plane.
- b Measured $1/16" \pm 1/32"$ along lead from seating plane.
- c Pulse duration of 300 μ seconds, duty factor 0.018.
- d See accompanying *Rise-Time-Measurement Circuit*.
- e See accompanying *Turn-On-Time and Turn-Off-Time Measurement Circuit*.

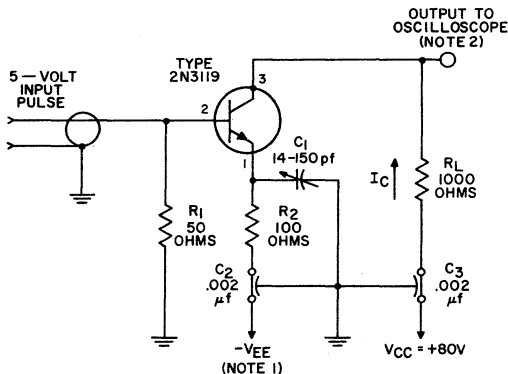
OPERATING CONSIDERATIONS

This transistor should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The *flexible leads* of this transistor are usually soldered to the circuit elements. Soldering of the leads may be made close to the glass stem provided care is taken to conduct excessive heat away from the lead seal. Otherwise, the heat of the soldering operation may crack the seals of the leads and damage the transistor.

It is to be noted that the case of this transistor operates at the collector voltage. Because of the possibility of shock hazard when the case of this transistor is at a voltage appreciably above or below ground potential, suitable precautionary measures should be taken.

RISE-TIME-MEASUREMENT CIRCUIT As a Pulse-Amplifier



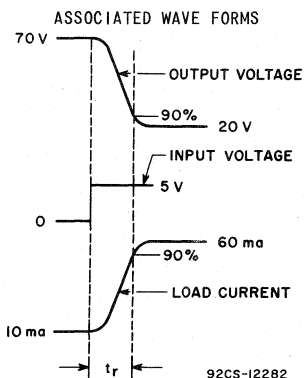
92CS-12279

Note 1: V_{EE} adjusted for $I_C = 10$ milliamperes with no input.

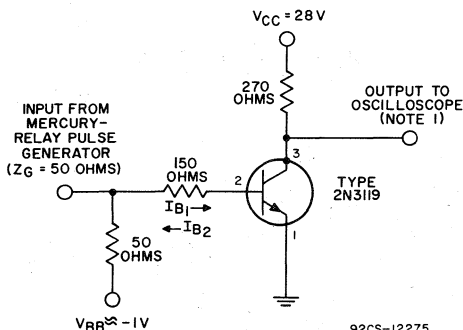
Note 2: With $C_{IN} < 1$ picofarad shunted by 100,000 ohms; $t_r = 1$ nanosecond.



2N3119



TURN-ON-TIME AND TURN-OFF-TIME MEASUREMENT CIRCUIT As a Saturated Switch

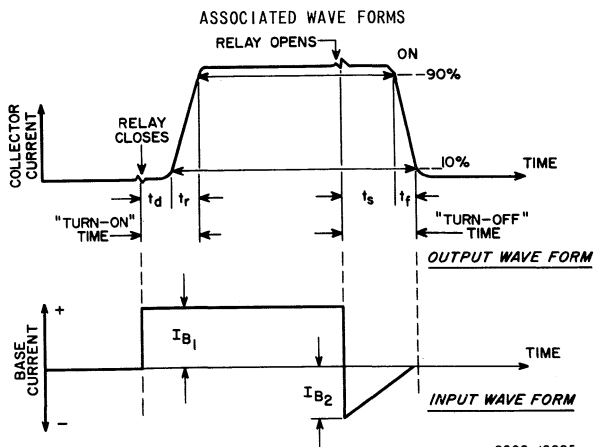


INPUT PULSE:

Repetition Rate = 120 cps
Pulse Width = 300 μ sec
 $t_r < 3$ nsec
 $t_f < 10$ nsec

Note 1: With $C_{IN} < 1$ picofarad shunted by 5,000 ohms; $t_r = 1$ nanosecond.

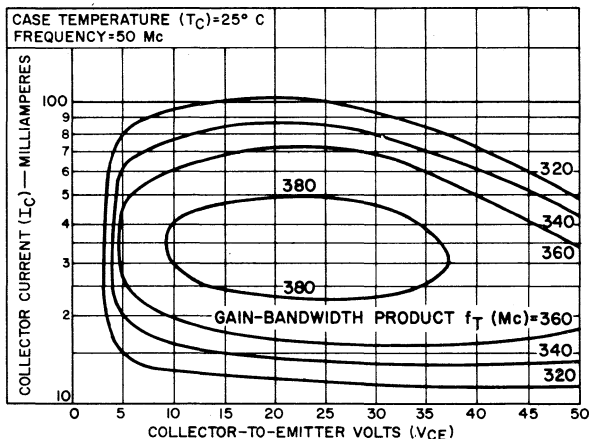




92CS-12285

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TYPICAL COLLECTOR-CURRENT CHARACTERISTICS



92CS-12286

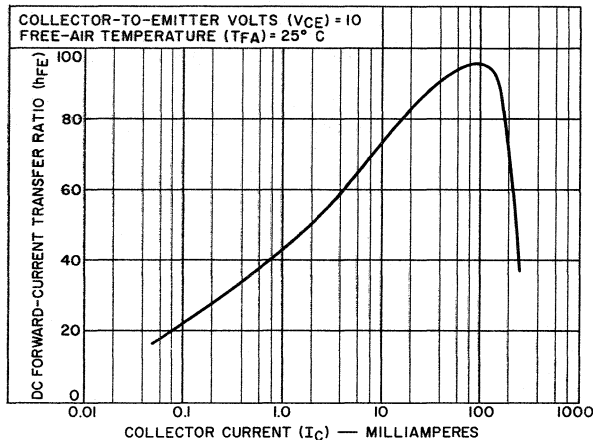


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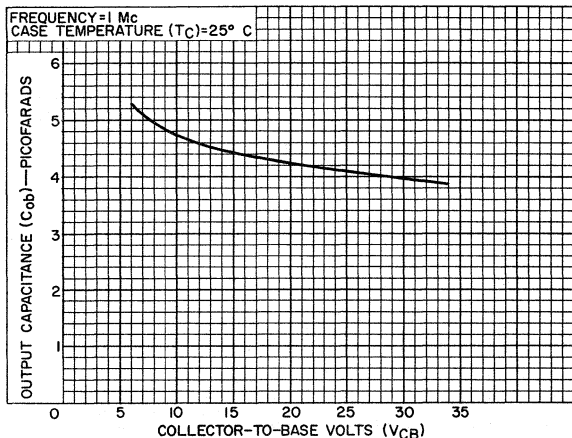
DATA 3
2-64

TYPICAL DC FORWARD-CURRENT TRANSFER-RATIO CHARACTERISTIC



92CS-12280

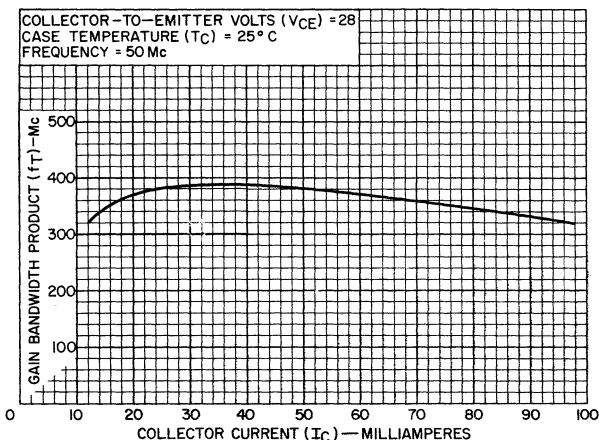
TYPICAL OUTPUT-CAPACITANCE CHARACTERISTIC



92CS-12283

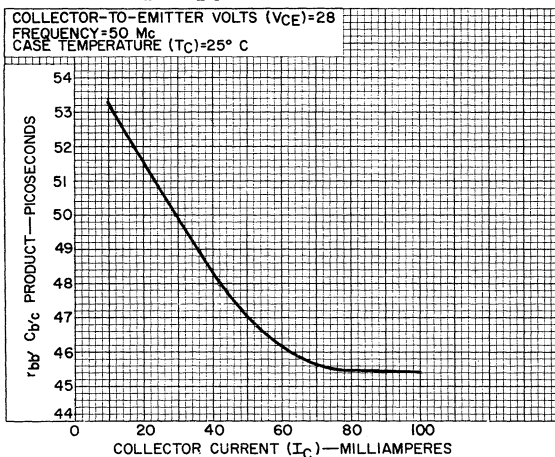


TYPICAL GAIN-BANDWIDTH PRODUCT CHARACTERISTIC



92CS-12287

TYPICAL $r_{bb'}$ $C_{b'c}$ -PRODUCT CHARACTERISTIC



92CS-12284



Silicon Controlled Rectifier (Thyristor)

ALL-DIFFUSED, 3-JUNCTION TYPE

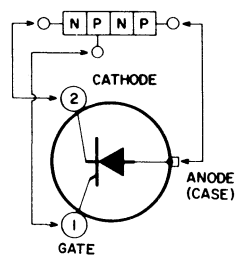
*For Low-Cost 120-Volt Line-Operated Power-Control
and Power-Switching Applications*

MECHANICAL

Dimensions See Outline TO-66 in General Section

TERMINAL DIAGRAM (Bottom View)

Pin 1—Gate
Pin 2—Cathode
Mounting Flange—Anode,
Case



The arrow indicates direction of forward current

ABSOLUTE-MAXIMUM RATINGS²

*Unless otherwise specified, for sinusoidal ac supply
voltage at a frequency between 50 and 400 Hz, with
resistive or inductive load*

Peak Reverse Voltage

Gate open:			
Repetitive	$V_{RM}(rep)$	200	V
Non-repetitive (Transient) for duration of 5 ms.	$V_{RM}(non-rep)$	330	V

Peak Forward Blocking Voltage

	$V_{FBOM}(rep)$	600	V
Repetitive, gate open			

Average Forward Current

T_C with heat sink from -65 to 75 °C			
DC Value at a conduction angle of 180°	I_{FAV}	3.2	A
RMS value.	I_{FRMS}	5	A

For other conditions, see *Rating
Chart (Case Temperature)*



Peak Surge Current

1 Cycle of applied
voltage
More than 1 cycle of
applied voltage . .

$i_{FM}(\text{surge})$ 60 A

$i_{FM}(\text{surge})$ See Peak-Surge Current
Rating Chart

→ **Sub-Cycle Surge^b** $I_2 t$ 15 A²s

Non-repetitive, for
a period of 1 ms to
8.3 ns

Rate of Change of→ **Forward Current** di/dt 200 A/ μ s

$V_{FB} = V_{B00}$ (min value)
 $I_{GT} = 200$ mA, 0.5 μ s
rise time

→ **Gate Power^c**

Peak, forward or re-
verse for 10 μ s
duration
Average

P_{GM}
 P_{GAV}

13 W
0.5 W

Temperature Range

Operating (Case) . .
Storage

T_{opr}
 T_{stg}

-40 to 100 °C
-40 to 125 °C

→ **ELECTRICAL CHARACTERISTICS**

Unless otherwise specified, at maximum electrical
ratings and at indicated case temperatures

Forward Breakover Voltage V_{B00} 200 min V
 $T_C = 100$ °C

Instantaneous Forward Voltage Drop V_F { 2.15 typ V
2.8 max V
 $T_C = 25$ °C, $i_F = 30$ A

DC Gate-Trigger Voltage V_{GT} { 1.2 typ V
2 max V
Anode to cathode volts = 6, $T_C = 25$ °C

Peak Blocking Current $T_C = 100$ °C

Forward, $V_{FB0}^d = V_{B00}$ (min value) i_{FB0M} { 0.1 typ mA
1.5 max mA

Reverse, $V_{RB0}^e = V_{RM}$ (rep value) i_{RB0M} { 0.05 typ mA
0.75 max mA

DC Gate-Trigger Current I_{GT} { 8 typ mA
15 max mA
Anode to cathode volts = 6, $T_C = 25$ °C

Holding Current i_{H00} { 10 typ mA
20 max mA
 $T_C = 25$ °C, with gate open

Critical Rate of Applied

Forward Voltage Critical dv/dt { 10 min V/ μ s
200 typ V/ μ s
 $V_{FB} = V_{B00}$ (min value), exponential
rise, $T_C = 100$ °C

Turn-On Time t_{on} { 0.75 min μ s
1.5 typ μ s
 $V_{FB} = V_{B00}$ (min value), $i_F = 4.5$ A,
 $I_{GT} = 200$ mA, 0.1 μ s rise time,
 $T_C = 25$ °C

→ Indicates a change.



Turn-Off Time. $\left\{ \begin{array}{l} 15 \text{ typ } \mu\text{s} \\ 50 \text{ max } \mu\text{s} \end{array} \right.$
 $i_F = 2 \text{ A}$, $50 \mu\text{s}$ pulse width, $dv_{FB}/dt = 20 \text{ V}/\mu\text{s}$,
 $di_F/dt = 30 \text{ A}/\mu\text{s}$, $I_{GT} = 200 \text{ mA}$, $T_C = 75^\circ\text{C}$

- a Terms, Symbols, and Definitions for the data given are shown in the General Section of the Handbook.
- b The non-recurrent surge capability of the device for sub-cycle pulses where I is RMS amperes and t is pulse duration in seconds.
- c Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.
- d V_{FBO} = DC forward blocking voltage with gate open.
- e V_{RBO} = DC reverse blocking voltage with gate open.

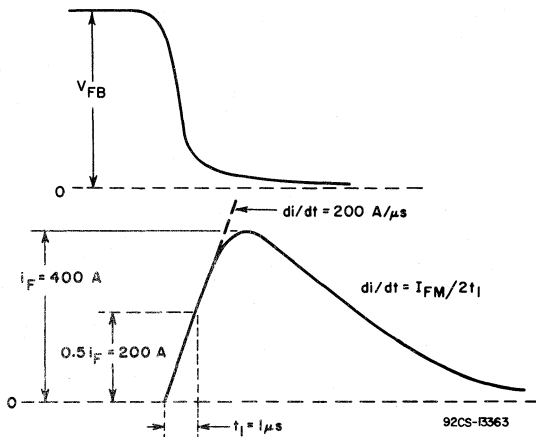
TRIGGERING CONSIDERATIONS

The construction of the gate-cathode junction used in these devices provides a large periphery center gate. These devices also employ integral-resistance construction which removes restrictions on both forward and reverse peak gate voltage and peak gate current. Limiting values of volt-ampere products for different gate pulse widths are shown under *Forward Gate Characteristics*. These limits should be adhered to when designing pulse trigger circuits for maximum trigger pulse widths and peak power dissipation. The volt-ampere products in the reverse direction shown under *Reverse Gate Characteristics* should be used to determine limitations for reverse gate transients or reverse gate pulses if present. In all cases, total average gate dissipation, both forward and reverse, should not exceed the average gate dissipation rating (P_{GAV}) of 0.5 watt.

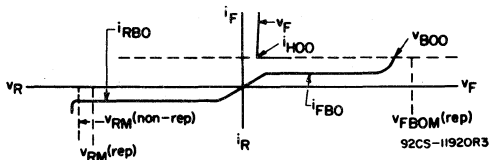
Turn-on times for different gate currents are shown under *Turn-On Time Characteristics*. These curves may be used to determine the required width of the gate trigger pulses. It is only necessary to maintain the gate trigger pulse until the magnitude of the forward anode current has reached the latching current value. However, conservative design required that the gate trigger pulse width be at least equal to or somewhat greater than the device turn-on time. Some applications may require wider gate pulse widths for proper circuit operation. Additional information on gate characteristics and triggering requirements for use in pulse applications are contained in RCA Application Note, SMA-39, "Gate Parameters of RCA SCR's for Trigger Circuit Design".



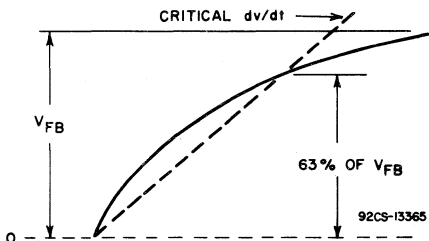
WAVESHAPE OF di/dt RATING TEST

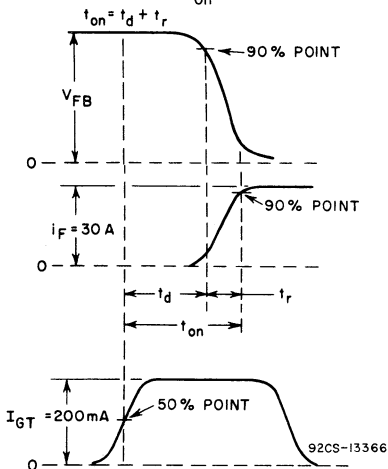
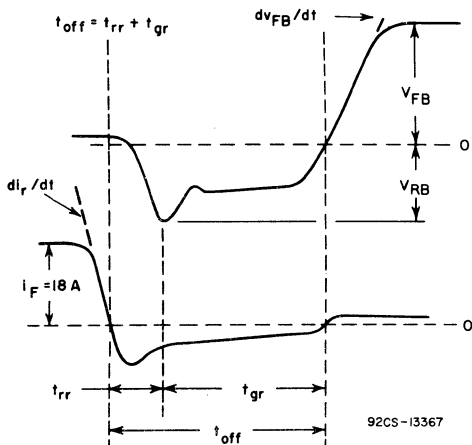


TYPICAL E-I CHARACTERISTIC OF SILICON CONTROLLED-RECTIFIER

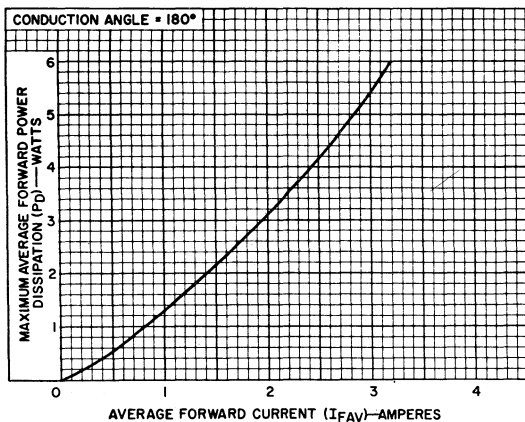


WAVESHAPE OF CRITICAL dv/dt RATING TEST

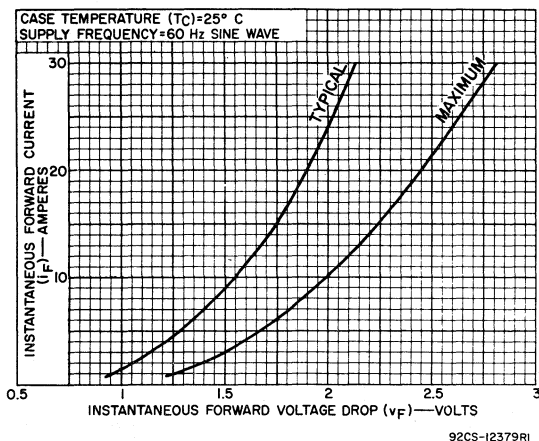


WAVESHAPE OF t_{on} RATING TESTWAVESHAPE OF t_{off} RATING TEST

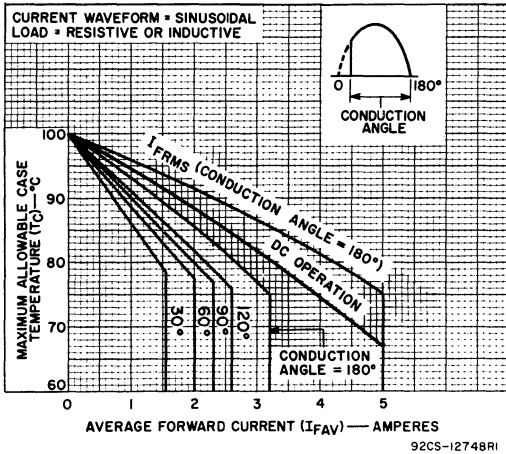
Power Dissipation Chart



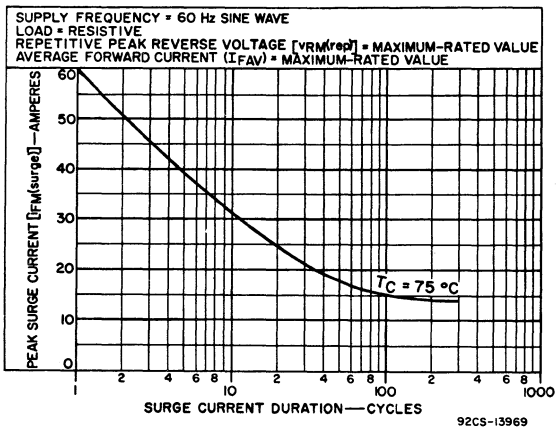
Forward Characteristics



Rating Chart (Case Temperature)



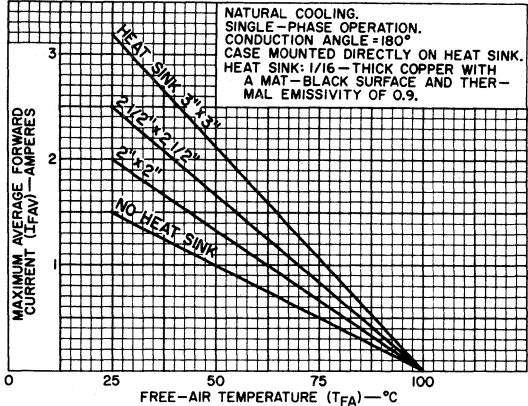
Peak Surge Current Rating Chart



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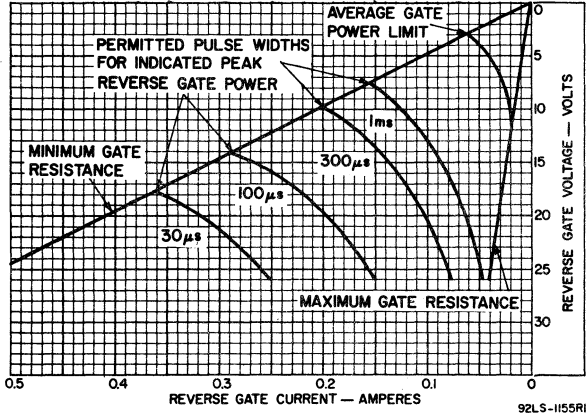
DATA 4
4-66

Natural-Air Cooling Operation Guidance Chart



92CS-12377

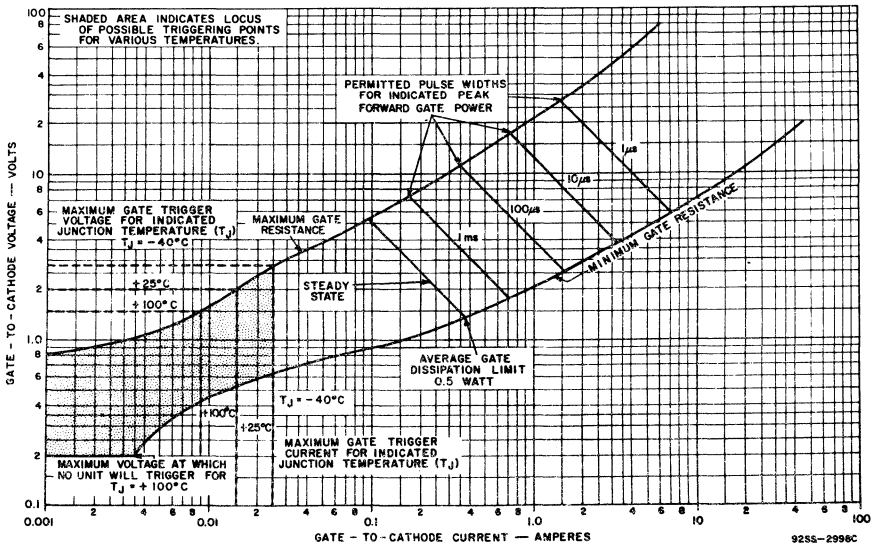
Reverse Gate Characteristics



92LS-1155RI



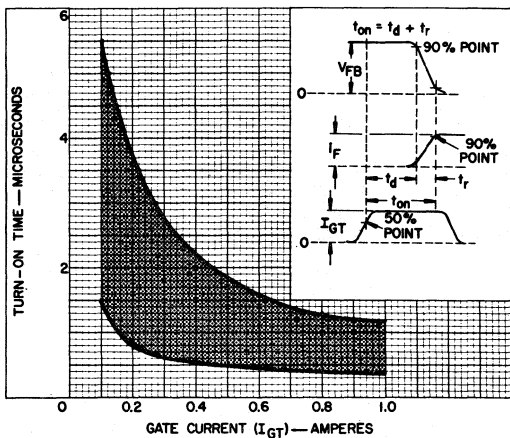
Forward Gate Characteristics



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DATA 5
4-66

Turn-On Time Characteristics



92SS-3000C



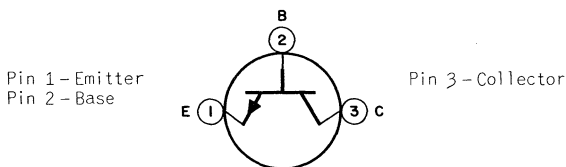
Transistor

SILICON N-P-N TRIPLE-DIFFUSED PLANAR TYPE
For Large-Signal, High-Power AM, FM, and CW
Applications at VHF Frequencies in Industrial and Military Communications Equipment

Mechanical:

Dimensions. See accompanying *Dimensional Outline*
Terminal Diagram (See accompanying *Dimensional Outline*):

TOP VIEW



All electrodes are electrically isolated from case

RADIO-FREQUENCY SERVICE

Maximum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage V_{CBO} 105 max. volts
With emitter open

Collector-to-Emitter Voltage

With reverse bias, $V_{EB} = 1.5$

volts V_{CEV} 105 max. volts

With base open. V_{CEO} 60 max. volts

Emitter-to-Base Voltage V_{EBO} 4 max. volts

With collector open

Collector Current I_C 2.5 max. amp

Transistor Dissipation

At case temperatures:

From -65° to 25° C. P_T 17.5 max. watts

Above 25° C. *Derate linearly*

0.1 watt/ $^{\circ}$ C

Temperature

Operating range (Junction). T_{opr} -65 to 200 $^{\circ}$ C

Storage range T_{stg} -65 to 200 $^{\circ}$ C

Pins (During soldering):^a

For 10 seconds maximum. T_p 230 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Case temperature = 25° C

Min. Typ. Max.

DC Collector-to-Base Breakdown

Voltage BV_{CBO} 105 - - volts

$I_C = 0.5$ ma., $I_E = 0$



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DATA 1
4-64

Min. Typ. Max.

DC Collector-to-Emitter

Breakdown Voltage

$I_C = 0.1$ ma., reverse bias

$V_{EB} = 1.5$ volts BV_{CEV} 105 - - volts

I_C (Pulsed) = 500 ma.,^b

$I_B = 0$ (Sustaining voltage). $BV_{CEO(sus)}$ 60 - - volts

DC Emitter-to-Base Breakdown

Voltage BV_{EBO} 4 - - volts

$I_E = 0.1$ ma., $I_C = 0$

DC Collector-to-Emitter

Saturation Voltage. $V_{CE(sat)}$ - - 1 volt

$I_C = 2.5$ amperes, $I_B = 500$ ma.

DC Collector-Cutoff Current .

$V_{CB} = 30$ volts, $I_E = 0$ I_{CBO} - - 0.1 μ a

Base-Spreading Resistance . .

$f = 400$ Mc, $V_{CE} = 28$ volts, $r_{bb'}$ - 6 - ohms

$I_C = 250$ ma.

Output Capacitance.

$f = 140$ kc, $V_{CB} = 30$ volts, C_{ob} - - 20 pf

$I_E = 0$

Collector-to-Case Capacitance

C_c - - 6 pf

Gain-Bandwidth Product. . . .

$V_{CE} = 28$ volts, $I_C = 250$ ma. f_T - 200 - Mc

RF Power Output,

Unneutralized:^c

$f = 50$ Mc, $V_{CC} = 50$ volts,

$I_C = 500$ ma., $P_i = 2$ watts P_o 15 - - watts

$f = 150$ Mc, $V_{CC} = 50$ volts,

$I_C = 250$ ma., $P_i = 1$ watt. P_o 5 - - watts

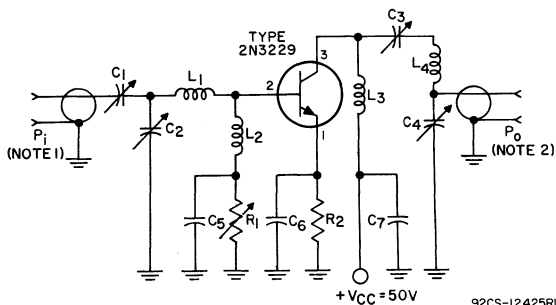
^a Measured along pin at distances not less than $1/32''$ from ceramic wafer.

^b Pulse duration ≤ 5 μ seconds, duty factor ≤ 0.01 .

^c See accompanying Power-Output-Measurement Circuit.



POWER-OUTPUT-MEASUREMENT CIRCUIT Unneutralized Amplifier



Note 1: Generator Impedance = 50 ohms.

Note 2: Load Impedance = 50 ohms.

For 50-Mc Operation

- C₁: 4-40 pf
- C₂, C₄: 7-100 pf
- C₃: 1.5-20 pf
- C₅, C₆, C₇: 0.005 μ f
- L₁: 5-1/2 turns No.18 wire, 1/4" inside diameter closely-wound
- L₂: Ferrite choke, Z = 750 ohms $\pm$ 20%
- L₃: 6 turns No.18 wire, 3/8" inside diameter, wire spacing = 1 wire diameter (slug-tuned)
- L₄: 8 turns No.18 wire, 3/8" inside diameter, closely-wound (Slug-tuned)
- R₁: 1000 ohms
- R₂: 3.9 ohms (non-inductive)

For 150-Mc Operation

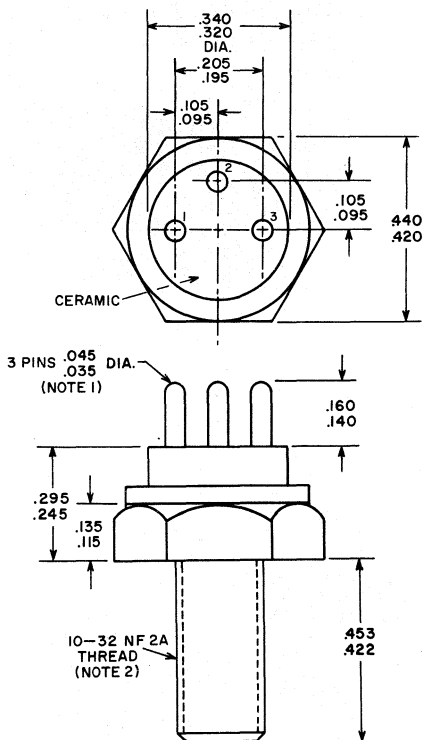
- C₁, C₂: 4-40 pf
- C₃, C₄: 1.5-20 pf
- C₅, C₇: 0.005 μ f
- L₁: 1-1/2 turns No.16 wire, 1/4" inside diameter, wire spacing = 1 wire diameter
- L₂: Ferrite choke, Z = 750 ohms $\pm$ 20%
- L₃: 2.4 μ h
- L₄: 6 turns No.16 wire, 3/8" inside diameter, closely-wound
- R₁: 100 ohms
- R₂: = 0 (Emitter connected to ground)

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DATA 2
4-64



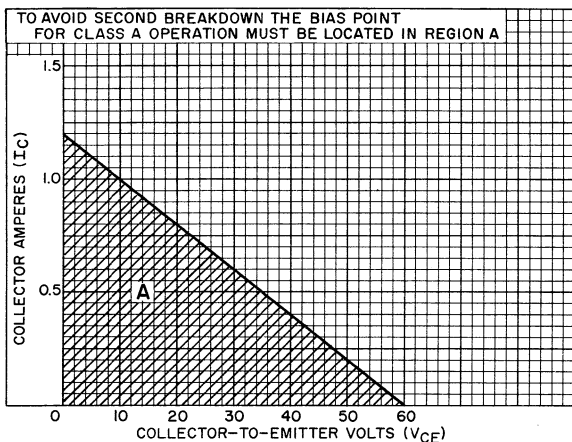
92CS-12045R1

Dimensions in Inches

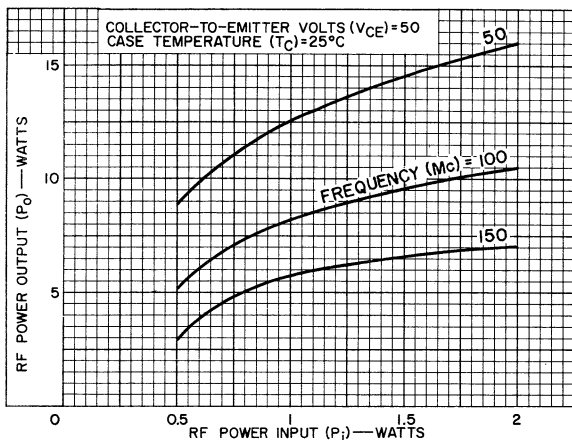
Note 1: The pin spacing permits insertion in any socket having a pin-circle diameter of 0.200 inch and contacts which will accommodate pins having a diameter of 0.035 inch minimum, 0.045 inch maximum.

Note 2: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12-inch pounds.

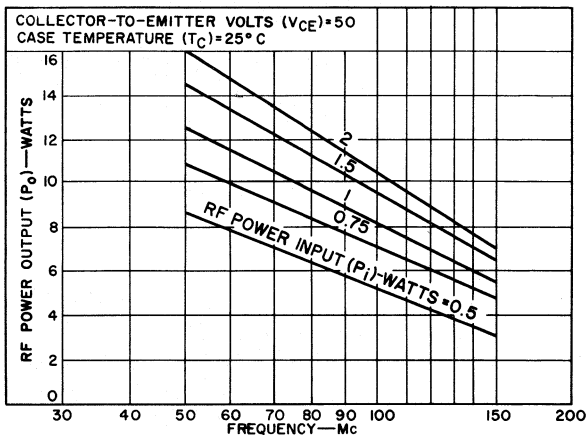
Region of Safe Operation Without Second-Breakdown in Class-A Service



Typical Operation Characteristics



Typical Operation Characteristics



92CS-12427



2N3241, 2N3242

Transistors

SILICON N-P-N PLANAR TYPES

COLLECTOR INTERNALLY
CONNECTED TO CASE

HERMETICALLY SEALED
PACKAGE

For High-Gain, Low-Noise Amplifier Applications
in Commercial and Industrial Equipment. Type
2N3242 is Particularly Useful in High Input-
Impedance, Direct-Coupled Amplifier Stages.

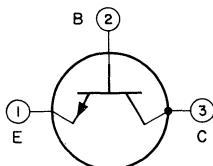
Mechanical:

Dimensions. See accompanying *Dimensional Outline*

Terminal Diagram

BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

Maximum Ratings, Absolute-Maximum Values:

	2N3241	2N3242	
Collector-to-Base Voltage. . . V_{CBV}	30	30	max. volts
With reverse bias $V_{EB}=1$ volt			
Collector-to-Emitter Voltage . V_{CEO}	25	25	max. volts
With base open			
Emitter-to-Base Voltage. . . . V_{EBO}	5	5	max. volts
With collector open			
Collector Current. I_C	100	200	max. ma
Emitter Current. I_E	100	200	max. ma
Transistor Dissipation			
At case temperatures ^a			
From -65° to 75° C P_T	2	2	max. watts
Above 75° C.	Derate linearly 0.02 watt/°C		
At free-air temperatures			
From -65° to 25° C P_T	0.5	0.5	max. watt
Above 25° C.	Derate linearly 0.0033 watt/°C		
Temperature			
Operating range (Junction) . T_{opr}	-65 to 175		°C
Storage range. T_{stg}	-65 to 175		°C
Lead-Soldering Temperature ^b . T_L	255	255	max. °C
(For 10 sec. max.)			



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DATA 1
8-64

2N3241, 2N3242

ELECTRICAL CHARACTERISTICS

Free-air temperature = 25°C , unless otherwise specified

	2N3241	2N3242
DC Collector-to-Base Breakdown Voltage. . . . BV_{CBV}	30	30 min. volts
$I_C = 50\text{ }\mu\text{a}$, reverse bias $V_{EB} = 1\text{ volt}$		
DC Collector-to-Emitter Breakdown Voltage. . . . BV_{CEO}	25	25 min. volts
$I_C = 10\text{ ma.}$, $I_B = 0$		
DC Emitter-to-Base Breakdown Voltage. . . . BV_{EBO}	5	5 min. volts
$I_E = 50\text{ }\mu\text{a}$, $I_C = 0$		
DC Collector-to-Emitter Saturation Voltage. . . . $V_{CE(sat)}$	0.5	0.5 typ. volt
$I_C = 50\text{ ma.}$, $I_B = 2.5\text{ ma}$	1	1 max. volt
DC Base-to-Emitter Saturation Voltage. . . . $V_{BE(sat)}$	0.8	0.8 typ. volt
$I_C = 50\text{ ma.}$, $I_B = 2.5\text{ ma}$		
DC Collector-Cutoff Current		
$V_{CB} = 25\text{ volts}$, $I_E = 0$,		
$T_{FA} = 25^{\circ}\text{C}$ I_{CBO}	100	10 max. na
$T_{FA} = 85^{\circ}\text{C}$ I_{CBO}	10	- max. μa
$T_{FA} = 150^{\circ}\text{C}$ I_{CBO}	-	10 max. μa
DC Emitter-Cutoff Current. I_{EBO}	100	10 max. na
$V_{EB} = 2.5\text{ volts}$, $I_C = 0$		
DC Forward-Current Transfer Ratio. h_{FE}	50	75 min.
$V_{CE} = 12\text{ volts}$, $I_C = 10\text{ ma}$	150	150 typ.
Small-Signal Short-Circuit Forward-Current Transfer Ratio. h_{fe}	70	100 min.
$f = 1\text{kc}$, $V_{CE} = 12\text{ volts}$, $I_C = 10\text{ ma}$	175	175 typ.
	250	375 max.
Gain-Bandwidth Product. f_T	60	60 typ. Mc
$V_{CE} = 6\text{ volts}$, $I_C = 1\text{ ma}$		
Base-Spreading Resistance $r_{bb'}$	20	20 typ. ohms
$f = 100\text{ Mc}$, $V_{CE} = 6\text{ volts}$, $I_C = 1\text{ ma}$		



2N3241, 2N3242

	2N3241	2N3242		
Output Capacitance. . . C_{ob}	22	22	typ.	pf
$f = 1 \text{ kc,}$ $V_{CB} = 6 \text{ volts,}$ $I_E = 0$				
Noise Figure				
$V_{CE} = 6 \text{ volts,}$ circuit bandwidth = 1 cps, $R_G = 1000 \text{ ohms}$				
$I_C = 0.1 \text{ ma,}$				
$f = 10 \text{ kc. . . NF}$	2.5	2	typ.	db
$I_C = 0.5 \text{ ma,}$				
$f = 1 \text{ kc. . . NF}$	8	4	typ.	db
	10	6	max.	db
Small-Signal				
Short-Circuit				
Input Impedance. . . h_{ie}	600	600	typ.	ohms
$f = 1 \text{ kc,}$ $V_{CE} = 12 \text{ volts,}$ $I_C = 10 \text{ ma}$				
Small-Signal				
Open-Circuit				
Output Admittance. . . h_{oe}	75	75	typ.	μmhos
$f = 1 \text{ kc,}$ $V_{CE} = 12 \text{ volts,}$ $I_C = 10 \text{ ma}$				
Small-Signal				
Open-Circuit				
Reverse Voltage-				
Transfer Ratio. . . h_{re}	125×10^{-6}	125×10^{-6}	typ.	
$f = 1 \text{ kc, } V_{CE} = 12$ volts, $I_C = 10 \text{ ma}$				
Thermal Resistance				
Junction-to-case. . . θ_{JC}	300	300	max.	$^{\circ}\text{C/w}$
Junction-to-free air θ_{JFA}	50	50	max.	$^{\circ}\text{C/w}$

^a Measured on case perimeter at junction with seating surface.

^b Measured along lead at distances not less than 1/32" from seating plane.

OPERATING CONSIDERATIONS

These transistors should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

In both the 2N3241 and the 2N3242 the collector is connected to the case. Consequently, in applications where the collectors of these transistors are operated at voltage above or below ground potential suitable precautions should be observed.



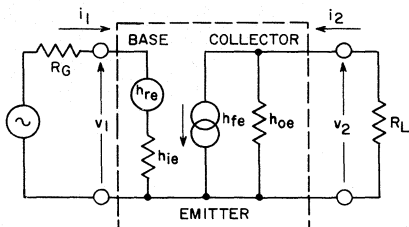
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DATA 2
8-64

2N3241, 2N3242

LOW-FREQUENCY SMALL-SIGNAL EQUIVALENT CIRCUIT CHARACTERISTICS FOR TYPES 2N3241 AND 2N3242



92CS-12535

$$\text{Input Resistance} = \frac{V_1}{i_1} = \frac{h_{ie} + (\Delta h R_L)}{1 + (h_{oe} R_L)}$$

$$\text{Output Resistance} = \frac{V_2}{i_2} = \frac{h_{ie} + R_G}{\Delta h + (h_{oe} R_G)}$$

V_1 = ac input signal voltage

i_1 = ac base current

V_2 = ac output signal voltage

i_2 = ac collector current

$\Delta h = (h_{ie} h_{oe}) - (h_{re} h_{fe})$

R_G = generator resistance

R_L = load resistance

Forward Current-

$$\text{Transfer Ratio} = \frac{i_2}{i_1} = \frac{h_{fe}}{1 + (h_{oe} R_L)}$$

Forward Voltage-

$$\text{Transfer Ratio} = \frac{V_2}{V_1} = \frac{-h_{fe} R_L}{h_{ie} + (\Delta h R_L)}$$

h_{ie} = small-signal short-circuit input impedance

h_{oe} = small-signal open-circuit output admittance

h_{re} = small-signal open-circuit

reverse voltage-transfer ratio

h_{fe} = small-signal short-circuit

forward current-transfer ratio

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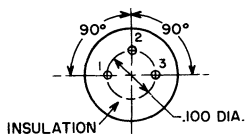
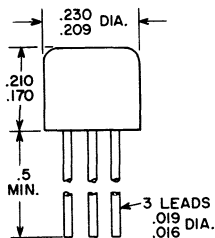
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2N3241, 2N3242

DIMENSIONAL OUTLINE FOR TYPES 2N3241 AND 2N3242



92CS-12478

DIMENSIONS IN INCHES



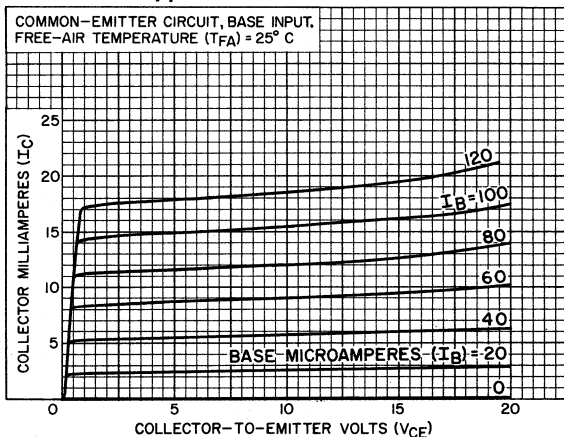
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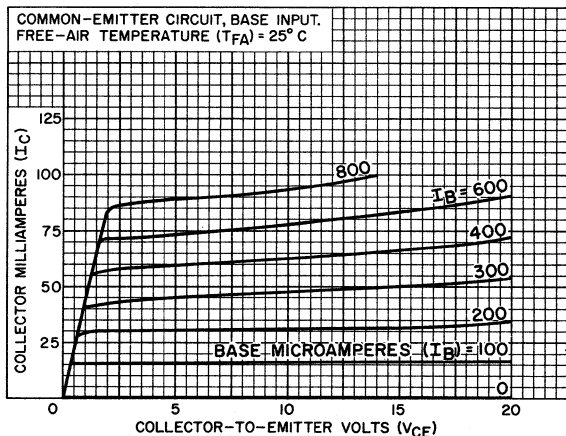
DATA 3
8-64

2N3241, 2N3242

Typical Collector Characteristics for Types 2N3241 and 2N3242



92CS-12390

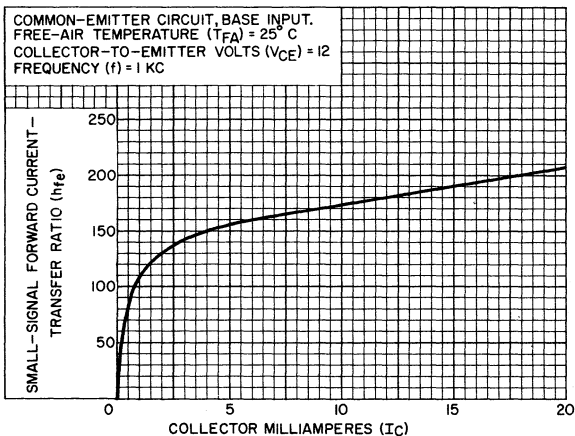


92CS-12397

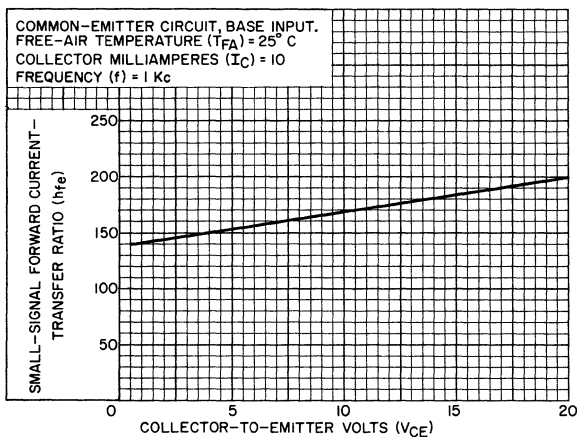


2N3241, 2N3242

Typical Small-Signal Forward-Current Transfer-Ratio Characteristics for Types 2N3241 and 2N3242



92CS-12385



92CS-12386



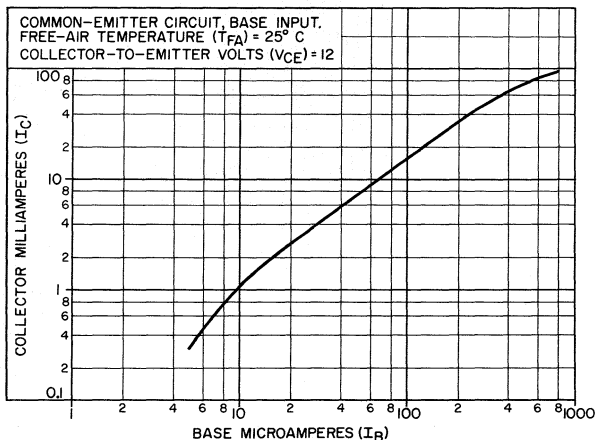
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DATA 4
8-64

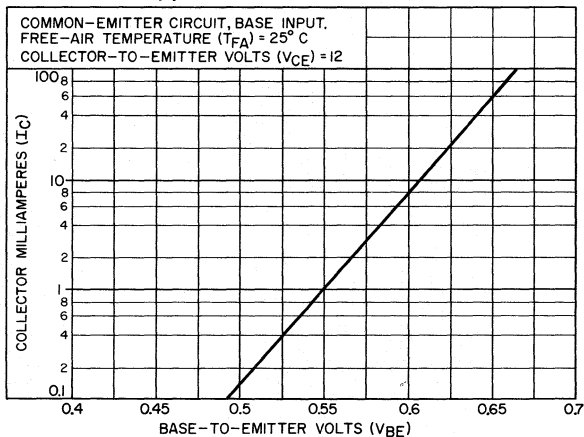
2N3241, 2N3242

Typical DC Forward-Current Transfer-Ratio Characteristic for Types 2N3241 and 2N3242



92CS-12387

Typical Transfer Characteristic for Types 2N3241 and 2N3242



92CS-12389



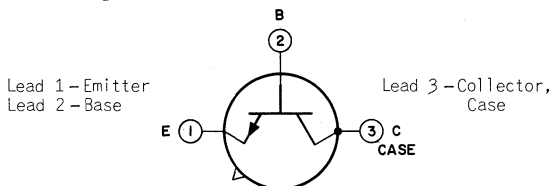
Transistor

SILICON N-P-N PLANAR EPITAXIAL TYPE

*For High-Speed Switching Applications In Military
and Commercial Data-Processing Equipment such
as Digital-Logic Circuits, Terminated-Line-
Driver Service, and as a Memory Driver*

Dimensions. See Outline TO-52 in General Section

Terminal Diagram: **BOTTOM VIEW**



SWITCHING SERVICE

MAXIMUM RATINGS, Absolute-Maximum Values

Collector-to-Base Voltage	V_{CB0}	40	V
Collector-to-Emitter Voltage.	V_{CE0}	15	V
Emitter-to-Base Voltage	V_{EB0}	6	V
Collector Current	I_C	500	mA

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C.	P_T	I	W
Above 25° C.	Derate linearly to 0 W at 175° C		

At free-air temperatures:

From -65° to 25° C.	P_T	0.3	W
Above 25° C.	Derate linearly to 0 W at 175° C		

Temperature Range

Operating.	T_{opr}	-65 to 175	°C
Storage.	T_{stg}	-65 to 200	°C
Lead-Soldering Temperature ^b	T_L	230	°C

(For 10 sec. max.)

ELECTRICAL CHARACTERISTICS

*Unless otherwise specified, electrode voltage
and electrode-current values for given test
conditions are dc at case temperature = 25° C*

		Min	Typ	Max	
Collector-to-Base Breakdown Voltage.	BV_{CB0}	40	55	-	V
$I_C = 0.01$ mA, $I_E = 0$					



Min. Typ. Max.

Collector-to-Emitter

Breakdown Voltage. BV_{CEO} 15 17 - V
 I_C (Pulsed) = 10 mA, $I_B = 0$

Emitter-to-Base

Breakdown Voltage. BV_{EBO} 6 8 - V
 $I_E = 0.01$ mA, $I_C = 0$

Base-to-Emitter

Saturation Voltage $V_{BE(sat)}$ 0.8 0.93 1.1 V
 $I_C = 100$ mA, $I_B = 10$ mA

Collector-to-Emitter

Saturation Voltage $V_{CE(sat)}$ - 0.28 0.35 V
 I_C (Pulsed) = 100 mA, $I_B = 10$ mA

Base-Cutoff Current

I_{BEV} - -5 -25 nA
 $V_{CE} = 15$ V, $V_{EB} = 0$

Collector-Cutoff Current

$V_{CE} = 15$ V, $V_{EB} = 0$,
 $T_{FA} = 25^\circ$ C. I_{CEV} - 5 25 nA
 $T_{FA} = 150^\circ$ C. I_{CEV} - 6.5 25 μ A

DC Forward-Current

Transfer Ratio

$V_{CE} = 1$ V,
 $T_{FA} = 25^\circ$ C, $I_C = 10$ mA. . . h_{FE} 40 60 150
 $T_{FA} = 25^\circ$ C,
 I_C (Pulsed) = 100 mA^c. . . h_{FE} 30 50 -
 $T_{FA} = 25^\circ$ C,
 I_C (Pulsed) = 200 mA^c. . . h_{FE} 20 35 -
 $T_{FA} = -55^\circ$ C, $I_C = 10$ mA. . . h_{FE} 20 35 -

Small-Signal Forward-

Current Transfer Ratio

$f = 100$ Mc/s,
 $V_{CE} = 1$ V, $I_C = 100$ mA. . . h_{fe} 3 4.4 -
 $V_{CE} = 10$ V, $I_C = 10$ mA. . . h_{fe} 6 8.3 -

Input Capacitance

C_{ib} - 3 4 pF
 $f = 1$ Mc/s, $V_{EB} = 0.5$ V,
 $I_C = 0$

Output Capacitance

C_{ob} - 2.8 3.5 pF
 $f = 1$ Mc/s, $V_{CB} = 5$ V,
 $I_E = 0$

Delay Time^d

t_d - 4 6 ns
 $V_{CC} = 6$ V, $V_{BE(off)} = -4$ V,
 $I_{B1} = 10$ mA, $I_{CS} = 100$ mA,
 $I_{B2} = -10$ mA

Rise Time^d

t_r - 4.8 7 ns
 $V_{CC} = 6$ V, $V_{BE(off)} = -4$ V,
 $I_{B1} = 10$ mA, $I_{CS} = 100$ mA,
 $I_{B2} = -10$ mA

Fall Time^d

t_f - 3.5 6 ns
 $V_{CC} = 6$ V, $I_{B1} = 10$ mA,
 $I_{CS} = 100$ mA, $I_{B2} = -10$ mA



		Min	Typ	Max	
Storage Time ^d	t_s	-	7	10	ns
$V_{CC} = 6\text{ V}, I_{B1} = 10\text{ mA},$ $I_{CS} = 100\text{ mA}, I_{B2} = -10\text{ mA}$					
Storage Time ^e	t_s	-	6	10	ns
$V_{CC} = 10\text{ V}, I_{B1} = 10\text{ mA},$ $I_{CS} = 10\text{ mA}, I_{B2} = -10\text{ mA}$					

^a Measured at center of seating surface.

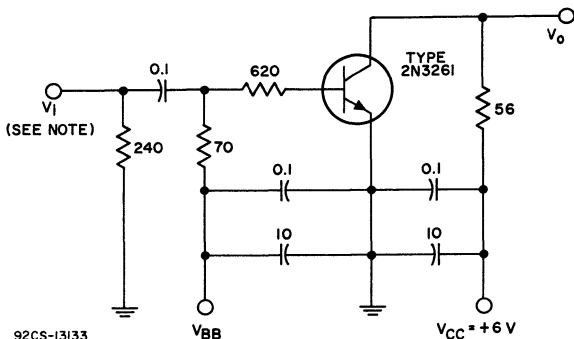
^b Measured along lead at distance $\geq 1/16$ inch from seating surface.

^c Pulse duration $\leq 100\text{ }\mu\text{s}$, duty factor ≤ 0.02 .

^d See accompanying *Switching Time Test Circuit*.

^e See accompanying *Storage Time Test Circuit*.

SWITCHING TIME TEST CIRCUIT

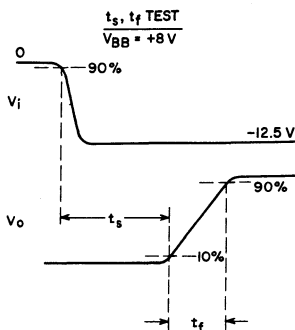
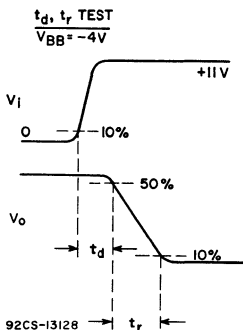


92CS-13133

Note: V_i rise time $\leq 1\text{ ns}$, pulse width $\geq 100\text{ ns}$, duty cycle $\leq 2\%$.

Resistance values in ohms.

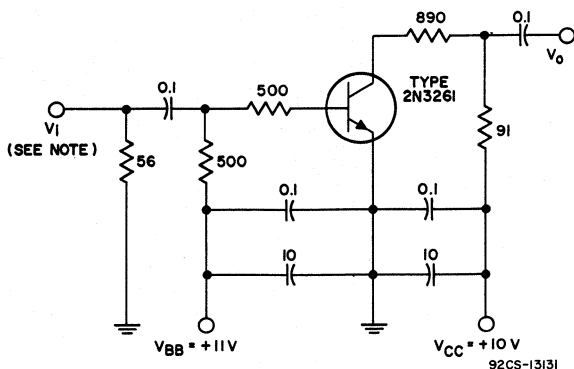
Capacitance values in μF .



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DATA 2
5-65

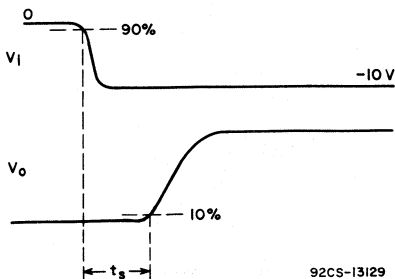
STORAGE TIME TEST CIRCUIT



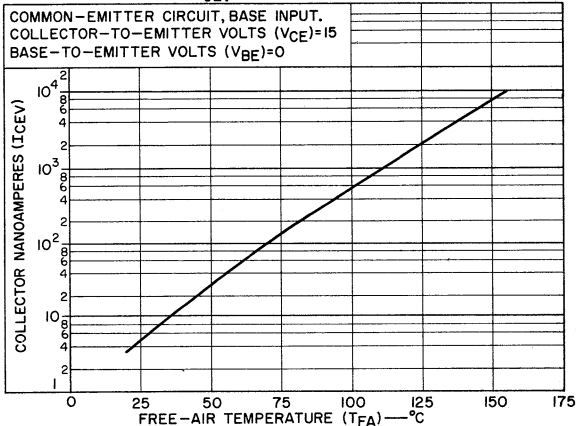
Note: V_i rise time ≤ 1 ns, pulse width ≥ 100 ns, duty cycle $\leq 2\%$.

Resistance values in ohms.

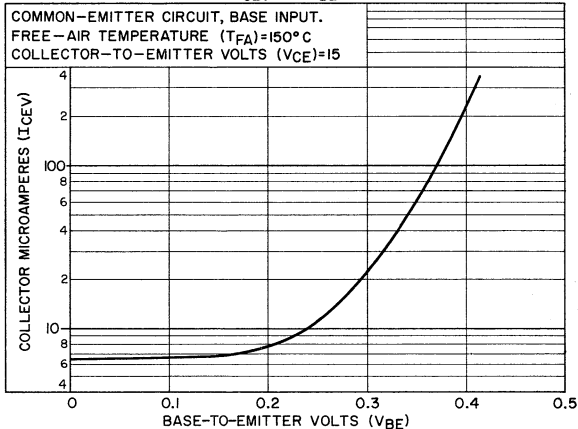
Capacitance values in μ F.



Typical Reverse Characteristics

 I_{CEV} vs TEMPERATURE

92CS-12549

 I_{CEV} vs V_{BE} 

92CS-12550RI

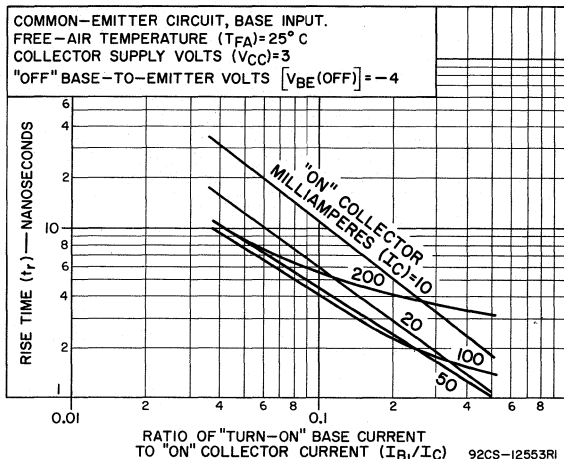


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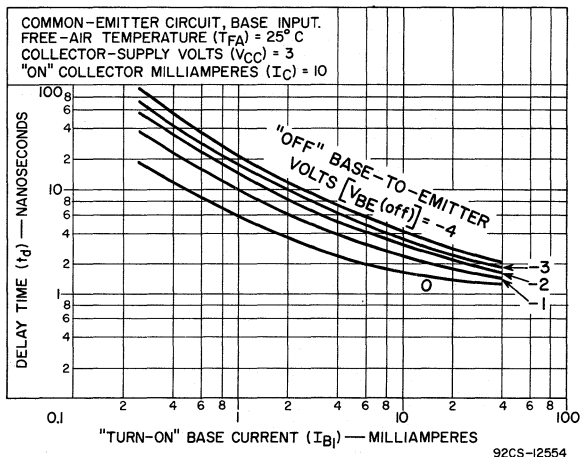
DATA 3
5-65

Typical "Turn-On" Characteristics

RISE TIME



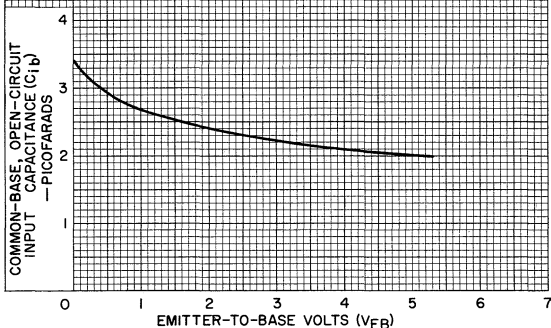
DELAY TIME



Typical Capacitance Characteristics

INPUT

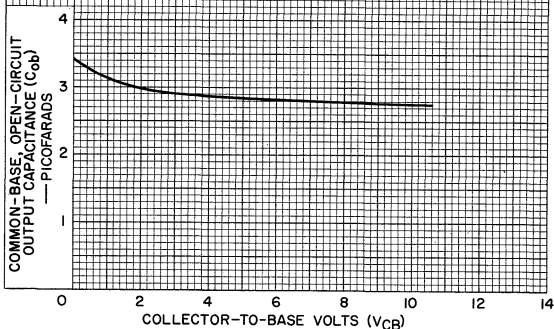
COMMON-BASE CIRCUIT, COLLECTOR OPEN.
 FREE-AIR TEMPERATURE (T_{FA}) = 25° C
 FREQUENCY (f) = 1 Mc
 COLLECTOR CURRENT (I_C) = 0



92CS-12547

OUTPUT

COMMON-BASE CIRCUIT, EMITTER OPEN.
 FREE-AIR TEMPERATURE (T_{FA}) = 25° C
 FREQUENCY (f) = 1 Mc
 EMITTER CURRENT (I_E) = 0



92CS-12548



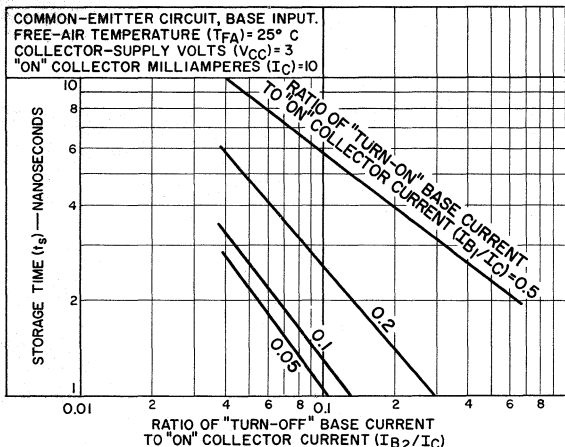
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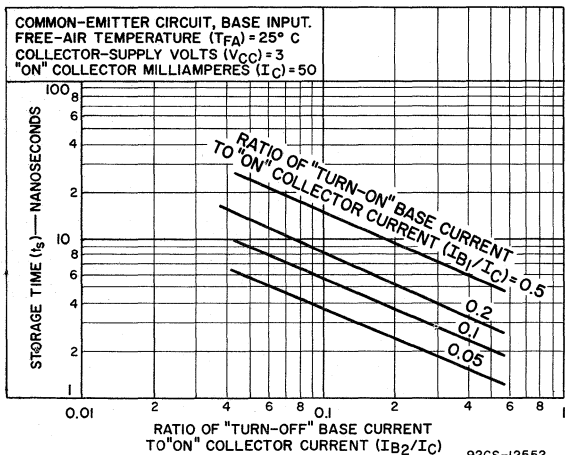
DATA 4
 5-65

Typical "Turn-Off" Characteristics

STORAGE TIME



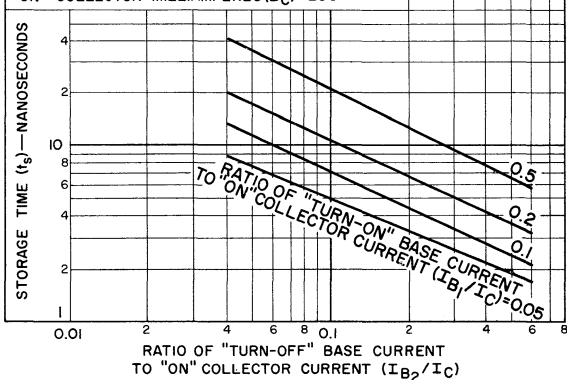
STORAGE TIME



Typical "Turn-Off" Characteristics

STORAGE TIME

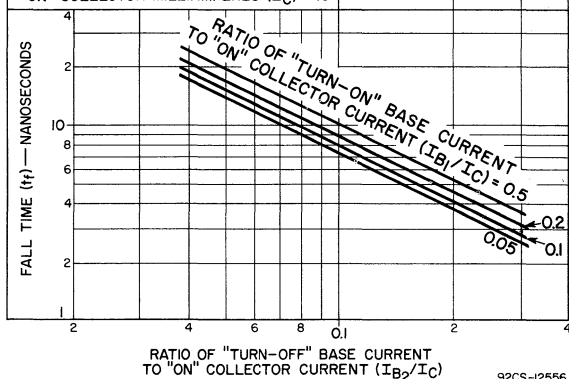
COMMON-EMITTER CIRCUIT, BASE INPUT.

FREE-AIR TEMPERATURE (T_{FA}) = 25° CCOLLECTOR-SUPPLY VOLTS (V_{CC}) = 3"ON" COLLECTOR MILLIAMPERES (I_C) = 200

92CS-12559

FALL TIME

COMMON-EMITTER CIRCUIT, BASE INPUT.

FREE-AIR TEMPERATURE (T_{FA}) = 25° CCOLLECTOR-SUPPLY VOLTS (V_{CC}) = 3"ON" COLLECTOR MILLIAMPERES (I_C) = 10

92CS-12556



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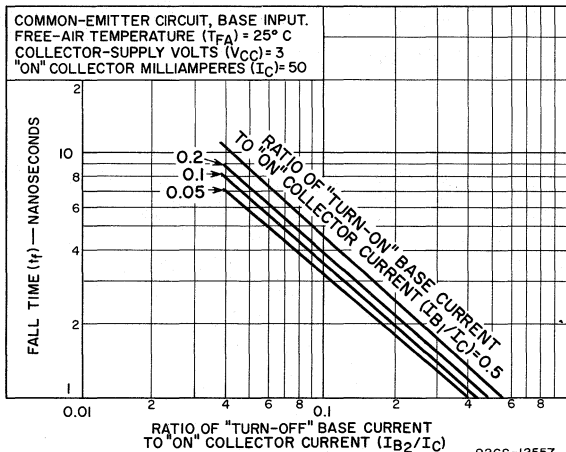
Harrison, N. J.

DATA 5

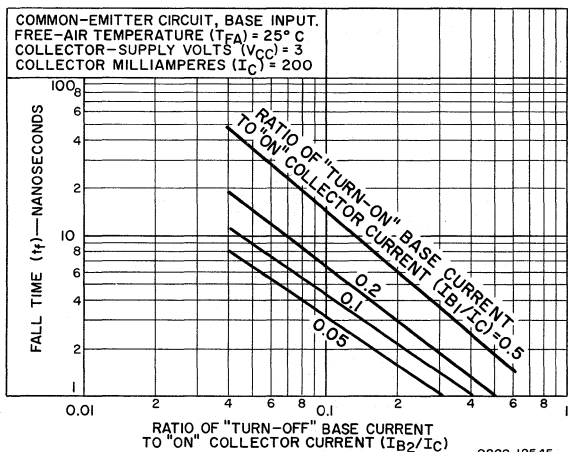
5-65

Typical "Turn-Off" Characteristics

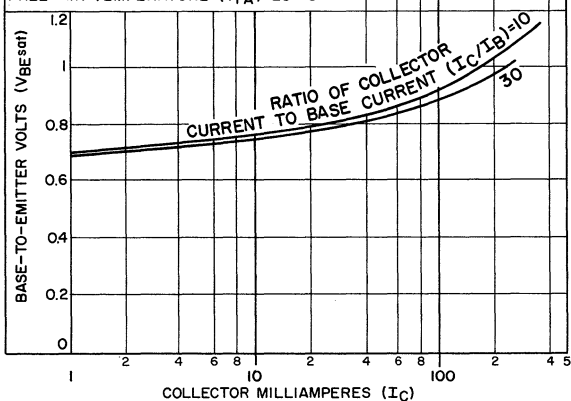
FALL TIME



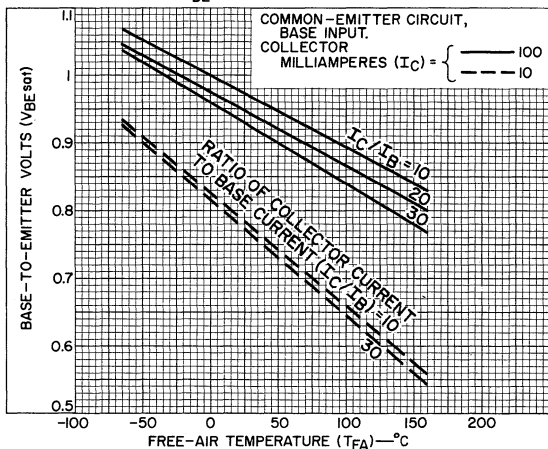
FALL TIME



Typical Saturation Voltage Characteristics

 $V_{BE(sat)}$ vs I_C COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE (T_{FA}) = 25° C

92CS-12536RI

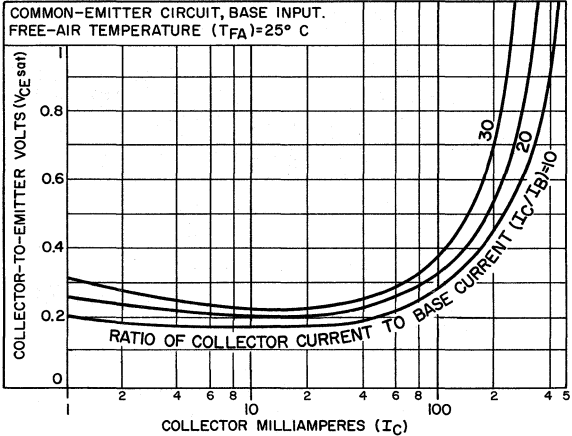
 $V_{BE(sat)}$ vs TEMPERATURE

92CS-12544RI

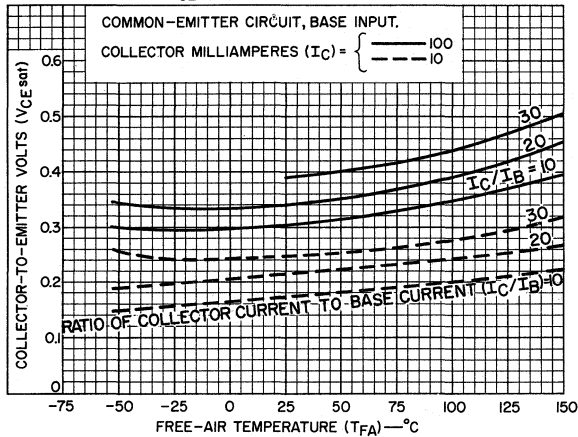
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5-65

Typical Saturation Voltage Characteristics

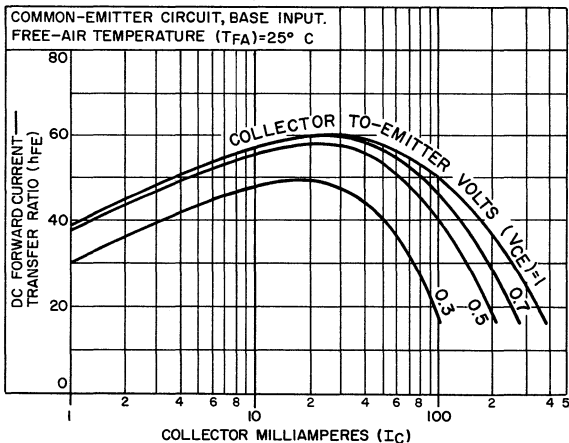
$V_{CE(sat)}$ vs I_C



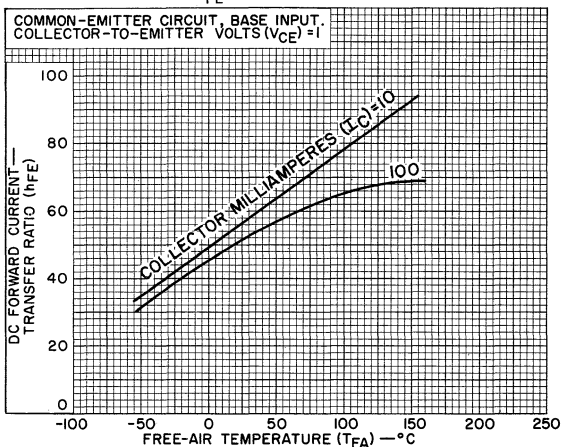
$V_{CE(sat)}$ vs TEMPERATURE



Typical Beta Characteristics

 h_{FE} vs I_C 

92CS-12538

 h_{FE} vs TEMPERATURE

92CS-12555



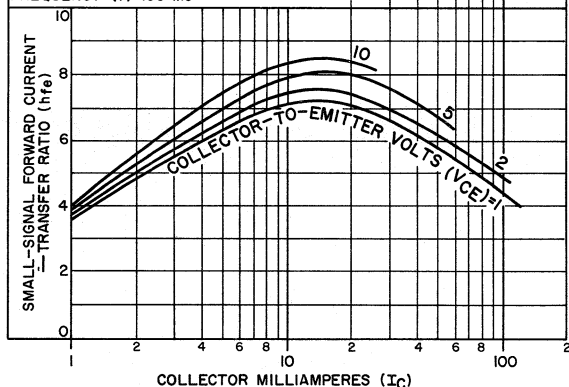
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DATA 7
5-65

Typical Beta Characteristics

100 Mc h_{fe} vs I_C

COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE (T_{FA}) = 25° C
FREQUENCY (f) = 100 Mc



92CS-12539



Transistor

SILICON N-P-N TRIPLE-DIFFUSED PLANAR TYPE

For High-Voltage, High-Frequency Pulse Amplifier and High-Voltage Saturated Switching Applications in Industrial and Military Equipment

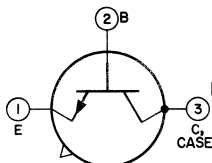
Mechanical:

Dimensions. See Outline TO-39 in General Section

Terminal Diagram

BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

Maximum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage . . . V_{CBO} 100 max. volts
With emitter open

Collector-to-Emitter Voltage

With reverse bias,

$V_{EB} = 1.5$ volts V_{CEX} 100 max. volts

With base open. $V_{CEO(sus)}$ 80 max. volts

Emitter-to-Base Voltage V_{EBO} 4 max. volts

With collector open

Collector Current I_C 1.5 max. amp

Transistor Dissipation

At case temperatures:^a

From -65° to 25° C. P_T 8.75 max. watts

Above 25° C. Derate linearly 50 mw/ $^{\circ}$ C

At free-air temperatures:

From -65° to 25° C. P_T 1 max. watt

Above 25° C. Derate linearly 5.71 mw/ $^{\circ}$ C

Temperature

Operating range T_{opr} -65 to 200° C

Storage range T_{stg} -65 to 200° C

Leads:^b

For 10 seconds maximum. T_L 230 max. $^{\circ}$ C

ELECTRICAL CHARACTERISTICS

Case temperature^a = 25° C, unless otherwise specified

Min. Max.

DC Collector-to-Emitter

Breakdown Voltage BV_{CEX} 100 - volts

With reverse bias,

$V_{EB} = 1.5$ volts,

$I_C = 0.25$ ma.



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DATA 1

4-64

		Min.	Max.	
DC Emitter-to-Base				
Breakdown Voltage	BV_{EBO}	4	-	volts
$I_E = 0.1$, $I_C = 0$				
DC Collector-to-Emitter				
Sustaining Voltage				
I_C (Pulsed) = 500 ma. ^c				
$R_{BE} = 10$ ohms.	$V_{CER(sus)}$	90	-	volts
$I_B = 0$	$V_{CEO(sus)}$	80	-	volts
DC Base-to-Emitter				
Saturation Voltage	$V_{BE(sat)}$	-	1.4	volts
$I_C = 1$ ampere, $I_B = 100$ ma.				
DC Collector-to-Emitter				
Saturation Voltage	$V_{CE(sat)}$	-	0.6	volt
$I_C = 1$ ampere, $I_B = 100$ ma.				
DC Collector-Cutoff Current.				
$T_{FA} = 25^\circ C$, $V_{CB} = 30$ volts, $I_E = 0$	I_{CBO}	-	0.1	μa
DC Emitter-Cutoff Current. .				
$V_{EB} = 3$ volts, $I_C = 0$	I_{EBO}	-	100	μa
Input Capacitance.				
$f = 1$ Mc, $V_{EB} = 3$ volts, $I_C = 0$	C_{ib}	-	300	pf
Output Capacitance				
$f = 1$ MC, $V_{CB} = 28$ volts, $I_C = 0$	C_{ob}	-	20	pf
DC Forward-Current				
Transfer Ratio	h_{FE}	40	-	
$V_{CE} = 4$ volts, $I_C = 500$ ma.				
Small-Signal Short-Circuit				
Forward-Current				
Transfer Ratio	h_{fe}	3	-	
$f = 50$ Mc, $V_{CE} = 28$ volts, $I_C = 100$ ma.				
Pulse-Amplifier Rise Time ^d .				
$V_{CC} = 80$ volts, $I_C = 25$ ma.	t_r	-	20	nsec
Saturated Switch Turn-On				
Time ^e ($t_d + t_r$).	t_{on}	-	40	nsec
$V_{CC} = 28$ volts, $I_C = 1$ ampere, $I_{B1} = 100$ ma.				
Saturated Switch Turn-Off				
Time ^e ($t_s + t_f$).	t_{off}	-	750	nsec
$V_{CC} = 28$ volts, $I_C = 1$ ampere, $I_{B2} = -100$ ma.				

^a Measured at center of seating plane.

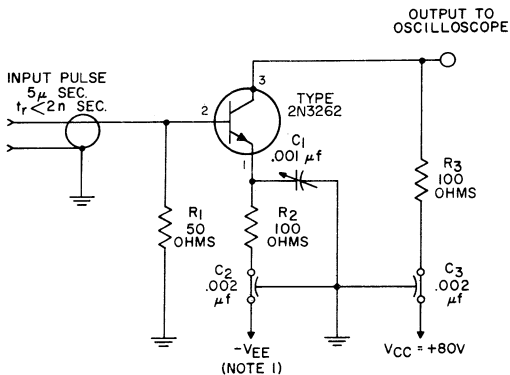
^b Measured $1/16" \pm 1/32"$ along lead from seating plane.

^c Pulse duration of 15 μ seconds, duty factor of 0.015.

^d See accompanying Rise-Time-Measurement Circuit.

^e See accompanying Turn-On-Time and Turn-Off-Time Measurement Circuit.

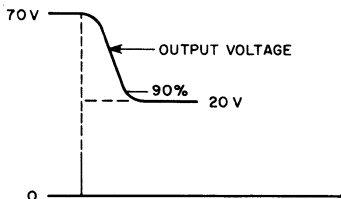
RISE-TIME-MEASUREMENT CIRCUIT As a Pulse-Amplifier



92CS-12464RI

Note 1: V_{EE} adjusted for $I_E = 35$ milliamperes with no input.

ASSOCIATED WAVE FORMS



92CS-12462

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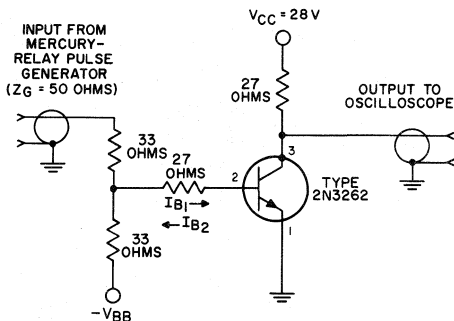
RADIO CORPORATION OF AMERICA
Electronic Components and Devices

Harrison, N. J.

DATA 2
4-64

2N3262

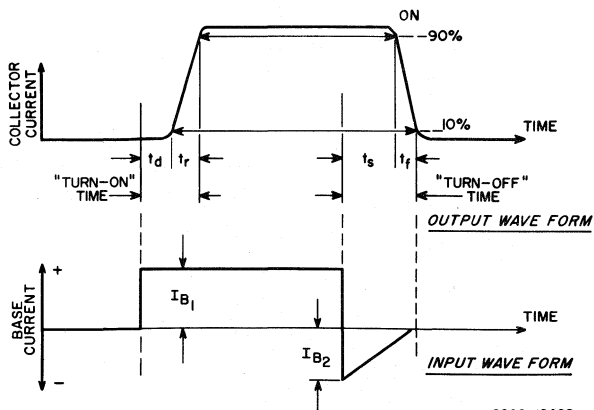
TURN-ON-TIME AND TURN-OFF-TIME MEASUREMENT CIRCUIT As a Saturated Switch



Input Pulse:

Repetition Rate = 120 cps
 Pulse Width = 300 μsec
 $t_r < 3 \text{ nsec}$
 $t_f < 10 \text{ nsec}$

ASSOCIATED WAVE FORMS

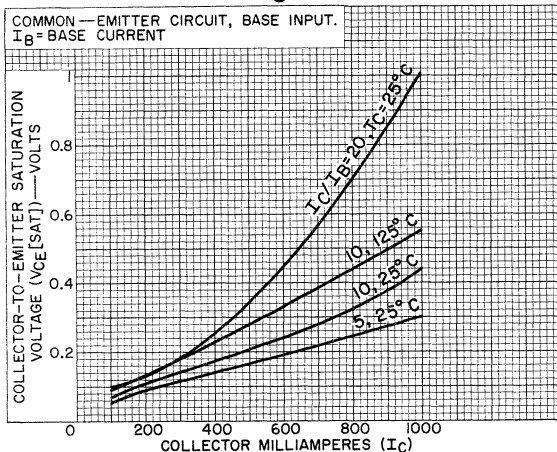


$I_{B1} = 100 \text{ ma}$
 $I_{B2} = -100 \text{ ma}$
 $I_C = 1 \text{ ampere}$

$t_{on} = 40 \text{ nsec}$
 $t_{off} = 750 \text{ nsec}$

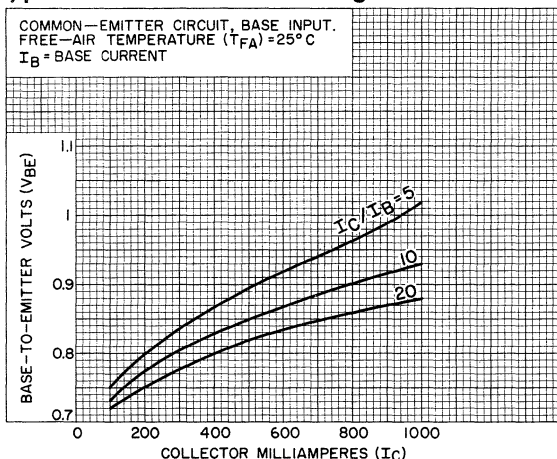


Typical Collector-to-Emitter Saturation-Voltage Characteristics



92CS-12461RI

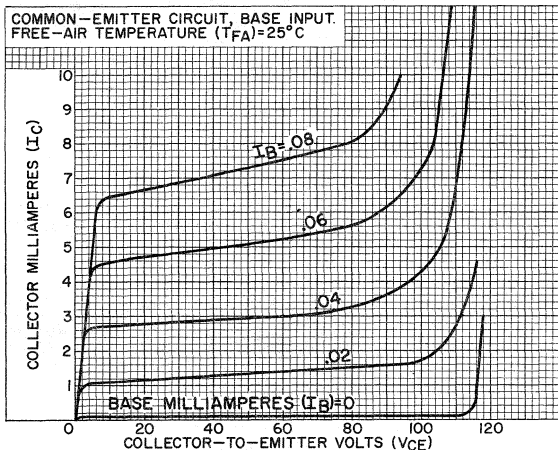
Typical Base-to-Emitter Voltage Characteristics



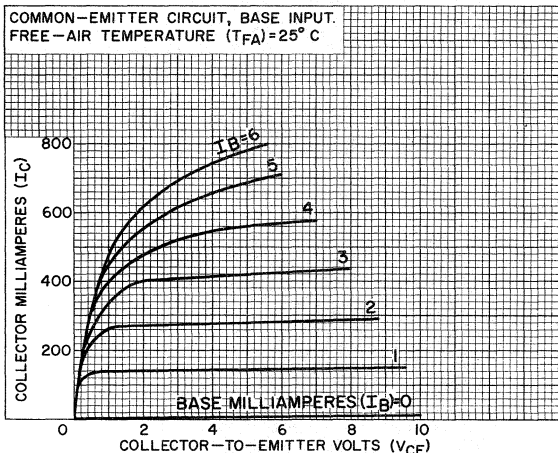
92CS-12451RI



Typical Collector Characteristics



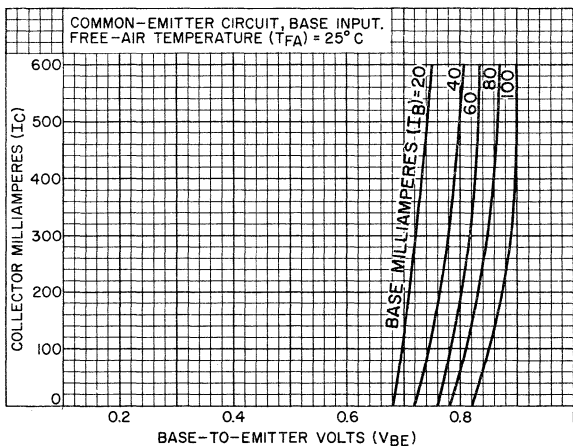
92CS-12454



92CS-12456

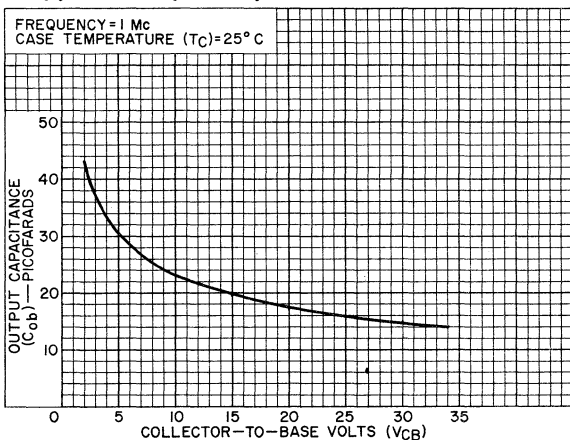


Typical Transfer Characteristics



92CS-12449

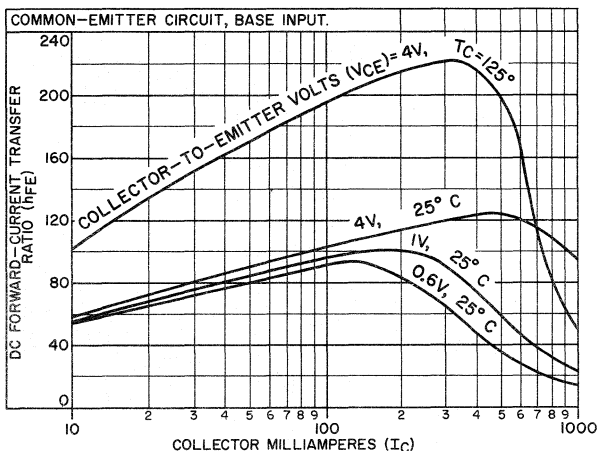
Typical Output-Capacitance Characteristic



92CS-12453

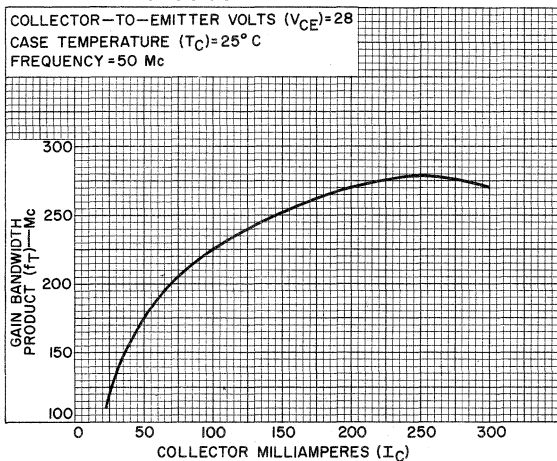


Typical DC Forward-Current Transfer-Ratio Characteristics



92CS-12450

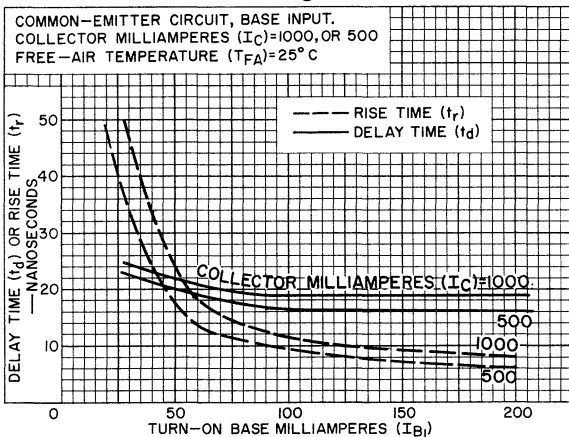
Typical Gain-Bandwidth Product Characteristic



92CS-12457

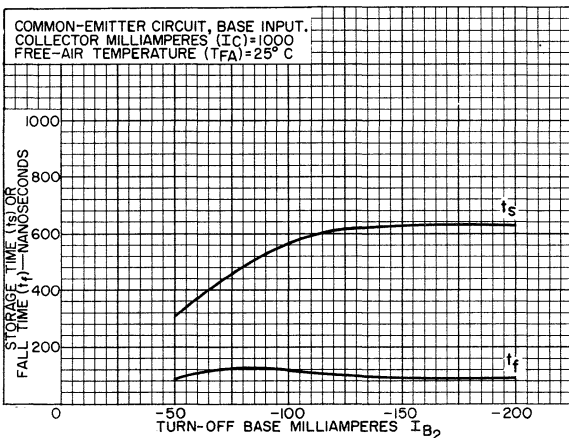


Typical Delay-Time and Rise-Time Saturated-Switching Characteristics



92CS-12458

Typical Storage-Time and Fall-Time Saturated-Switching Characteristics



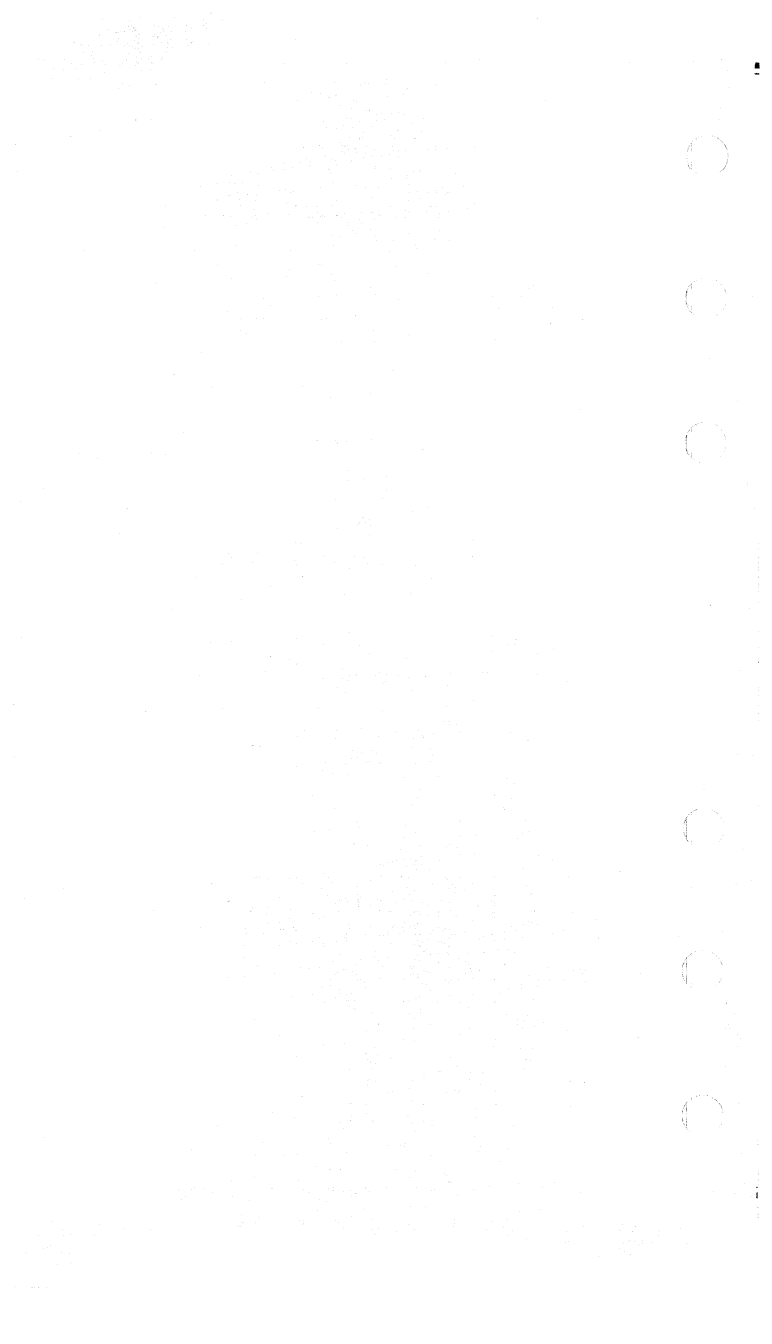
92CS-12459



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Electronic Components and Devices

Harrison, N. J.

DATA 5
4-64



Power Transistor

SILICON N-P-N EPITAXIAL TYPE

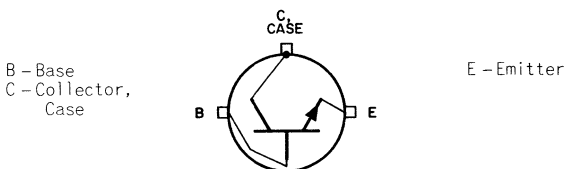
High-Power, High-Speed, and High-Current Type for
Switching, Amplifier, and Power Oscillator Applica-
tions in Aerospace, Military, and Industrial Equipment

Mechanical:

Dimensions. See accompanying *Dimensional Outline*

Terminal Diagram. . . (See accompanying *Dimensional Outline*):

TOP VIEW

Maximum Ratings, *Absolute-Maximum Values*:

Collector-to-Base Voltage. . .	V_{CBO}	150 max.	volts
With emitter open			
Collector-to-Emitter Voltage.	V_{CEX}	150 max.	volts
With reverse bias, $V_{EB} = 1.5$ volts			
Collector-to-Emitter Sustaining Voltage			
With $R_{BE} \leq 50$ ohms	$V_{CER(sus)}$	110 max.	volts
With base open	$V_{CEO(sus)}$	90 max.	volts
Emitter-to-Base Voltage.	V_{EBO}	7 max.	volts
With collector open			
Collector Current.	I_C	25 max.	amp
Base Current	I_B	10 max.	amp
Transistor Dissipation	P_T	See accompanying <i>Rating Chart</i>	
Temperature			
Operating range (Junction)	T_{opr}	-65 to 200	$^{\circ}C$
Storage range.	T_{stg}	-65 to 200	$^{\circ}C$
Thermal Resistance	θ_{JC}	1.5 max.	$^{\circ}C/watt$
Junction-to-case			

ELECTRICAL CHARACTERISTICS

Case temperature = $25^{\circ}C$, unless otherwise specified

DC Collector-to-Emitter

Min. Max.

Sustaining Voltage^a

$I_C = 0.2$, $R_{BE} \leq 50$ ohms.	$V_{CER(sus)}$	110	-	volts
$I_B = 0$	$V_{CEO(sus)}$	90	-	volts



RADIO CORPORATION OF AMERICA
Electronic Components and Devices

Harrison, N. J.

DATA 1
4-64

		Min.	Max.	
DC Emitter-to-Base Voltage.	V_{EBO}	7	-	volts
$I_E = 0.02$ amperes, $I_C = 0$				
DC Base-to-Emitter Saturation Voltage.	$V_{BE(sat)}$	-	1.6	volts
I_C (Pulsed) = 15 amperes ^b , $I_B = 1.5$ amperes				
DC Collector-to-Emitter Saturation Voltage.	$V_{CE(sat)}$	-	0.75	volt
I_C (Pulsed) = 15 amperes ^b , $I_B = 1.2$ amperes				
DC Collector Current.	I_{CEX}	-	20	ma
$V_{CE} = 150$ volts, reverse bias $V_{EB} = 1.5$ volts				
DC Collector-Cutoff Current				
$V_{CB} = 80$ volts, $I_E = 0$, $T_C = 25^\circ C$				
	I_{CBO}	-	4	ma
$125^\circ C$				
	I_{CBO}	-	4	ma
DC Emitter-Cutoff Current				
$V_{EB} = 5$ volts, $I_C = 0$, $T_C = 25^\circ C$				
	I_{EBO}	-	5	ma
$125^\circ C$				
	I_{EBO}	-	5	ma
Collector-to-Base Feed-back Capacitance.	$C_{b'c}$	-	900	pf
$f = 1$ Mc, $V_{CB} = 10$ volts, $I_E = 0$				
DC Forward-Current Transfer Ratio				
$V_{CE} = 3$ volts, I_C (Pulsed) = 5 amperes ^b				
	h_{FE}	40	-	
$V_{CE} = 3$ volts, I_C (Pulsed) = 15 amperes ^b				
	h_{FE}	25	75	
$V_{CE} = 4$ volts, I_C (Pulsed) = 20 amperes ^b				
	h_{FE}	20	-	
Gain-Bandwidth Product.	f_T	20	-	Mc
$f = 5$ Mc, $V_{CE} = 10$ volts, $I_C = 3$ amperes				
Saturated Switch Turn-On Time ($t_d + t_r$).	t_{on}	-	0.5	μsec
$V_{CC} = 30$ volts, $I_C = 15$ amperes, $I_{B1} = 1.2$ amperes, $I_{B2} = -1.2$ amperes				
Saturated Switch Storage Time.	t_s	-	1.5	μsec
$V_{CC} = 30$ volts, $I_C = 15$ amperes, $I_{B1} = 1.2$ amperes, $I_{B2} = -1.2$ amperes				

		Min.	Max.	
Saturated Switch Fall Time. . .	t_f	-	0.5	μsec
$V_{CC} = 30$ volts, $I_C = 15$ amperes, $I_{B1} = 1.2$ amperes, $I_{B2} = -1.2$ amperes				
Thermal Resistance.	θ_{JC}	-	1.5	$^{\circ}\text{C}/\text{watt}$
(Junction-to-case) $V_{CE} = 40$ volts, $I_C = 0.5$ ampere, $T_J = 100$ $^{\circ}\text{C}$				
Second-Breakdown Characteristics				
(Safe-Operating Region)				
Current at second-breakdown—				
$V_{CE} = 75$ volts.		350	-	ma
Energy at second-breakdown—				
reverse bias $V_{EB} = 6$ volts,				
$I_C = 10$ amperes,				
$R_{BE} = 20$ ohms,				
$L = 40$ μh		2	-	mjoules

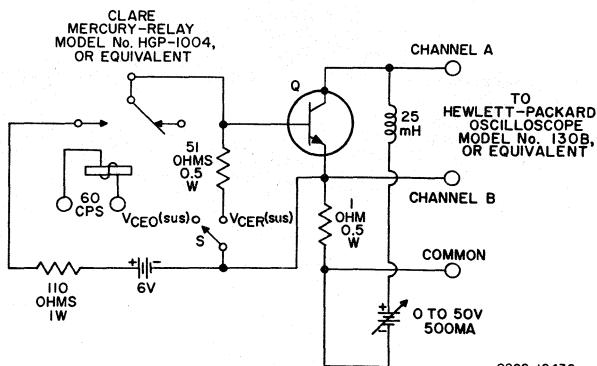
^a **CAUTION**—The sustaining voltages $V_{CEO}(\text{sus})$ and $V_{CER}(\text{sat})$ *MUST NOT* be measured on a curve tracer. These sustaining voltages should be measured by means of the accompanying *Sustaining-Voltage-Measurement Circuit*.

^b Pulse duration ≤ 350 $\mu\text{seconds}$, duty factor ≤ 0.02 .



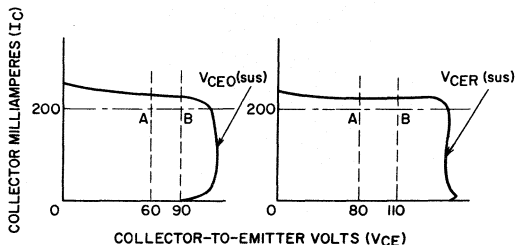
2N3263

Sustaining-Voltage-Measurement Circuit For $V_{CE0(sus)}$ and $V_{CER(sus)}$



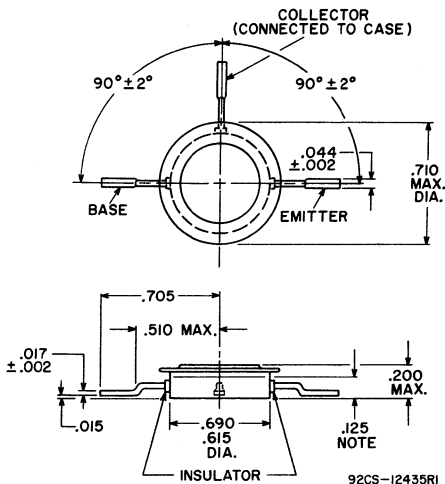
Q = 2N3263

Associated Traces for Above Circuit



The sustaining voltages $V_{CE0(sus)}$ and $V_{CER(sus)}$ are acceptable when the traces fall to the right and above points "A" for types 2N3264 and 2N3266. The traces must fall to the right and above points "B" for types 2N3263 and 2N3265.

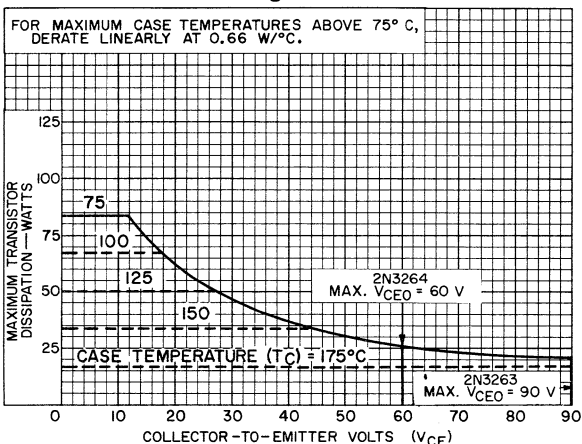




Dimensions in Inches

Note: The controlled area of the 0.690 maximum-0.615 minimum diameter does not include the brazed area around the ceramic and collector terminal.

Rating Chart



92CS-12433

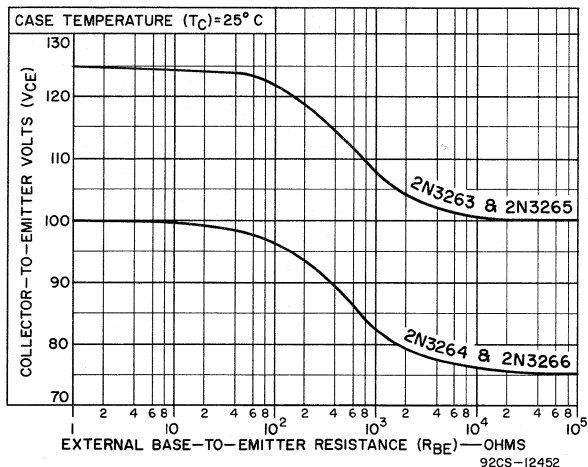


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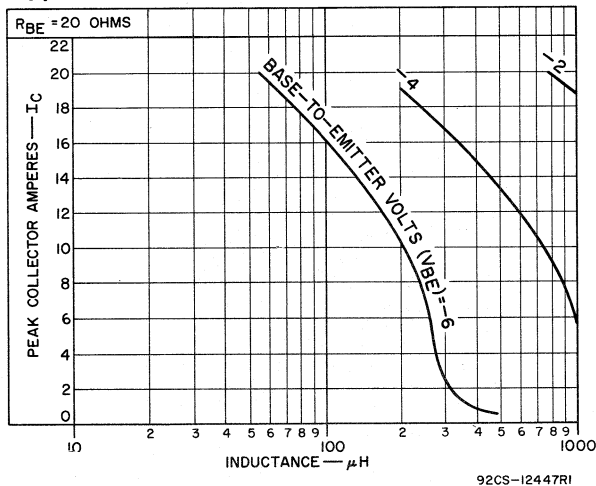
DATA 3
4-64

2N3263

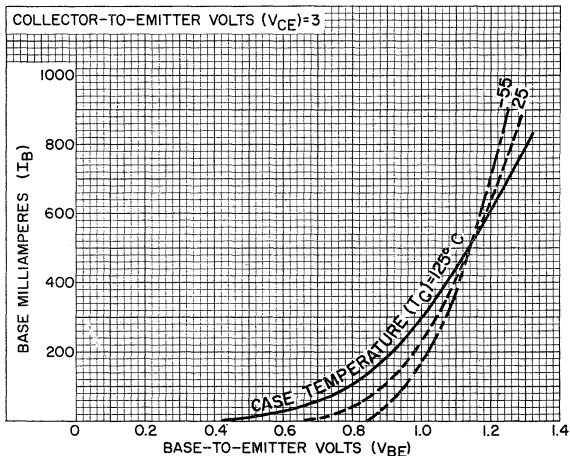
Typical Collector-to-Emitter Voltage Characteristics



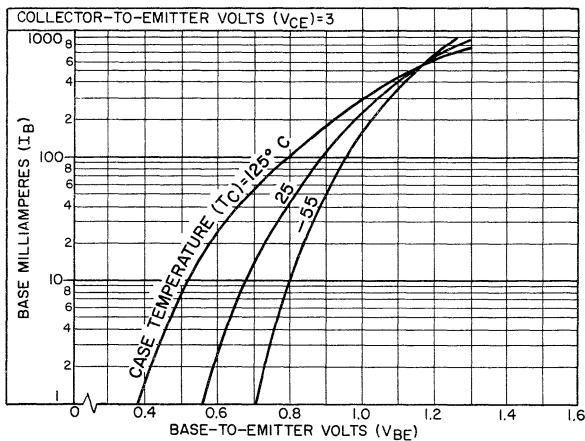
Typical Peak-Collector-Current Characteristics



Typical Base (Input) Characteristics



92CS-12438



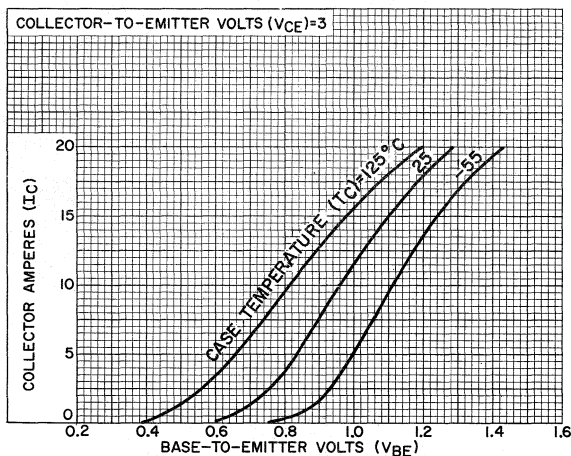
92CS-12431



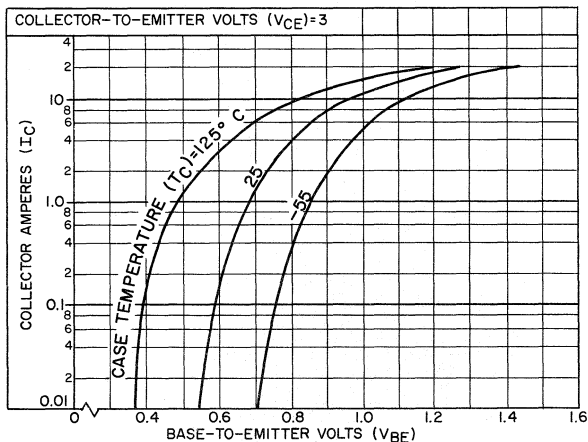
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Electronic Components and Devices Harrison, N. J.

DATA 4
4-64

Typical Transfer Characteristics



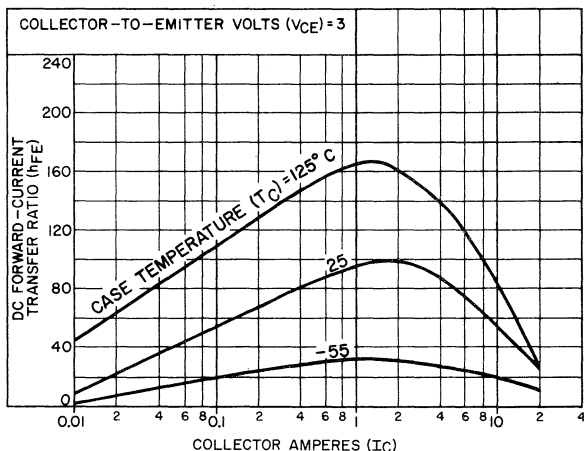
92CS-12442



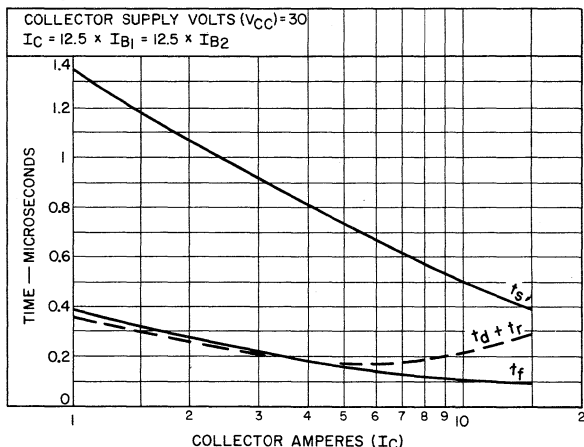
92CS-12437



Typical DC Forward-Current Transfer Ratio Characteristics

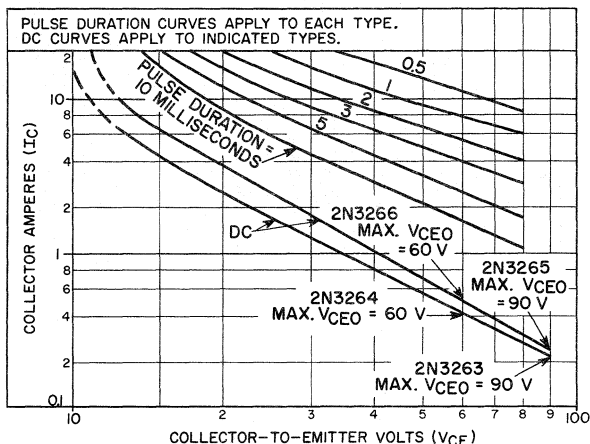


Typical Saturated-Switching Characteristics



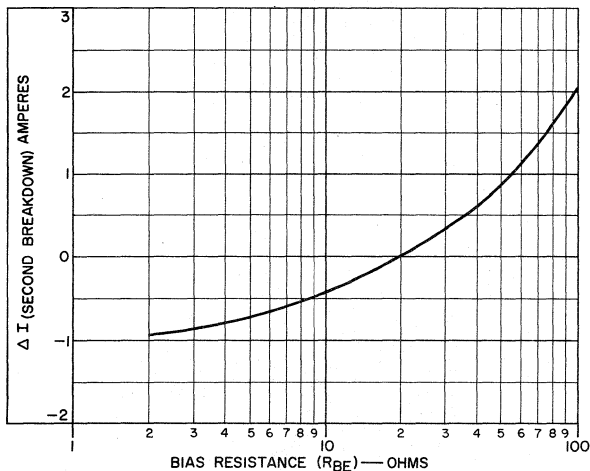
2N3263

Safe-Operating-Region as a Function of Pulse Width



92CS-12428

Second-Breakdown Current-Change Characteristics



92CS-12445

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Electronic Components and Devices

Harrison, N. J.



Power Transistor

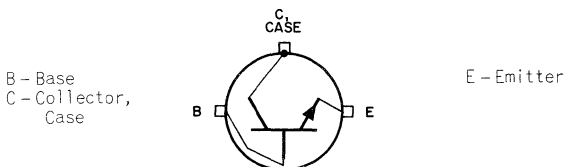
SILICON N-P-N EPITAXIAL TYPE

High-Power, High-Speed, and High-Current
Type for Switching, Amplifier, and Power
Oscillator Applications in Aerospace,
Military, and Industrial Equipment

Mechanical:

Dimensions. See accompanying *Dimensional Outline*
Terminal Diagram (See accompanying *Dimensional Outline*):

TOP VIEW



Maximum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage.	V_{CBO}	120 max.	volts
With emitter open			
Collector-to-Emitter Voltage	V_{CEX}	120 max.	volts
With reverse bias, $V_{EB} = 1.5$ volts			
Collector-to-Emitter Sustaining Voltage			
With $R_{BE} \leq 50$ ohms	$V_{CER(sus)}$	80 max.	volts
With base open	$V_{CEO(sus)}$	60 max.	volts
Emitter-to-Base Voltage.	V_{EBO}	7 max.	volts
With collector open			
Collector Current.	I_C	25 max.	amp
Base Current	I_B	10 max.	amp
Transistor Dissipation	P_T	See accompanying Rating Chart	
Temperature			
Operating range (Junction)	T_{opr}	-65 to 200	$^{\circ}C$
Storage range.	T_{stg}	-65 to 200	$^{\circ}C$
Thermal Resistance	θ_{JC}	1.5 max.	$^{\circ}C/watt$
Junction-to-case			

ELECTRICAL CHARACTERISTICS

Case temperature = $25^{\circ}C$, unless otherwise specified
Min. Max.

DC Collector-to-Emitter
Sustaining Voltage^a

$I_C = 0.2,$			
$R_{BE} \leq 50$ ohms,	$V_{CER(sus)}$	80	- volts
$I_B = 0.$	$V_{CEO(sus)}$	60	- volts



RADIO CORPORATION OF AMERICA
Electronic Components and Devices

Harrison, N. J.

DATA 1
4-64

	Min.	Max.	
DC Emitter-to-Base Voltage. V_{EBO} $I_E = 0.02$ amperes, $I_C = 0$	7	-	volts
DC Base-to-Emitter Saturation Voltage. $V_{BE(sat)}$ I_C (Pulsed) = 15 amperes ^b , $I_B = 1.5$ amperes	-	1.8	volts
DC Collector-to-Emitter Saturation Voltage. $V_{CE(sat)}$ I_C (Pulsed) = 1.5 amperes ^b , $I_B = 1.2$ amperes	-	1.2	volt
DC Collector Current. I_{CEX} $V_{CE} = 120$ volts, reverse bias $V_{EB} = 1.5$ volts	-	20	ma
DC Collector-Cutoff Current $V_{CB} = 60$ volts, $I_E = 0$, $T_C = 25^\circ C$ I_{CBO}	-	10	ma
125° C. I_{CBO}	-	10	ma
DC Emitter-Cutoff Current $V_{EB} = 5$ volts, $I_C = 0$, $T_C = 25^\circ C$ I_{EBO}	-	15	ma
125° C. I_{EBO}	-	15	ma
Collector-to-Base Feedback Capacitance $C_{b'c}$ $f = 1$ Mc, $V_{CB} = 10$ volts, $I_E = 0$	-	900	pf
DC Forward-Current Transfer Ratio $V_{CE} = 3$ volts, I_C (Pulsed) = 5 amperes ^b h_{FE}	35	-	
$V_{CE} = 3$ volts, I_C (Pulsed) = 15 amperes ^b h_{FE}	20	80	
$V_{CE} = 4$ volts, I_C (Pulsed) = 20 amperes ^b h_{FE}	15	-	
Gain-Bandwidth Product. f_T $f = 5$ Mc, $V_{CE} = 10$ volts, $I_C = 3$ amperes	20	-	Mc
Saturated Switch Turn-On Time ($t_d + t_r$). t_{on} $V_{CC} = 30$ volts, $I_C = 15$ amperes, $I_{B1} = 1.2$ amperes, $I_{B2} = -1.2$ amperes	-	0.5	μsec
Saturated Switch Storage Time t_s Storage Time. t_s $V_{CC} = 30$ volts, $I_C = 15$ amperes, $I_{B1} = 1.2$ amperes, $I_{B2} = -1.2$ amperes	-	1.5	μsec

	Min.	Max.	
Saturated Switch Fall Time. . . t_f	-	0.5	μsec
$V_{CC} = 30$ volts, $I_C = 15$ amperes,			
$I_{B1} = 1.2$ amperes, $I_{B2} = -1.2$ amperes			
Thermal Resistance (Junction-to-case). θ_{JC}	-	1.5	$^{\circ}\text{C}/\text{watt}$
$V_{CE} = 40$ volts, $I_C = 0.5$ amperes, $T_J = 100^{\circ}\text{C}$			
Second-Breakdown Characteristics (Safe-Operating Region)			
Current at second-breakdown- $V_{CE} = 75$ volts.			
Energy at second-breakdown— reverse bias $V_{EB} = 6$ volts, $I_C = 10$ amperes, $R_{BE} = 20$ ohms, $L = 40 \mu\text{h}$	700	-	ma
	2	-	mjoules

- ^a **CAUTION**—The sustaining voltages $V_{CE0}(\text{sus})$ and $V_{CEr}(\text{sus})$ *MUST NOT* be measured on a curve tracer. These sustaining voltages should be measured by means of the accompanying *Sustaining-Voltage-Measurement Circuit*.
- ^b Pulse duration $\leq 350 \mu\text{seconds}$, duty factor ≤ 0.02 .

Second-Breakdown Explanation,
Sustaining-Voltage-Measurement Circuit
and Associated Traces,
Dimensional Outline,
Rating Chart,
and
All Characteristics Curves
shown under type 2N3263 also apply to the 2N3264



Power Transistor

SILICON N-P-N EPITAXIAL TYPE

High-Power, High-Speed, and High-Current
Type for Switching, Amplifier, and Power
Oscillator Applications in Aerospace,
Military, and Industrial Equipment

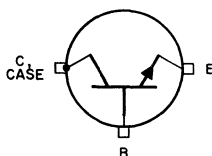
The 2N3265 is the same as the 2N3263 except for the following items:

Mechanical:

Dimensions. See accompanying Dimensional Outline
Terminal Diagram (See accompanying Dimensional Outline):

TOP VIEW

C - Collector,
Case
B - Base



E - Emitter

Maximum Ratings, Absolute-Maximum Values:

Transistor Dissipation. . . P_T See accompanying Rating Chart
Thermal Resistance. . . . θ_{JC} 1 max. $^{\circ}\text{C}/\text{watt}$
Junction-to-case

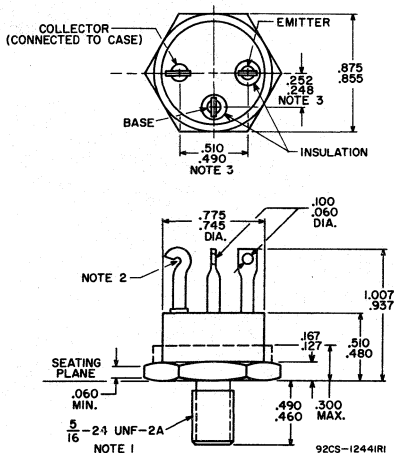
ELECTRICAL CHARACTERISTICS

Case temperature = 25°C , unless otherwise specified

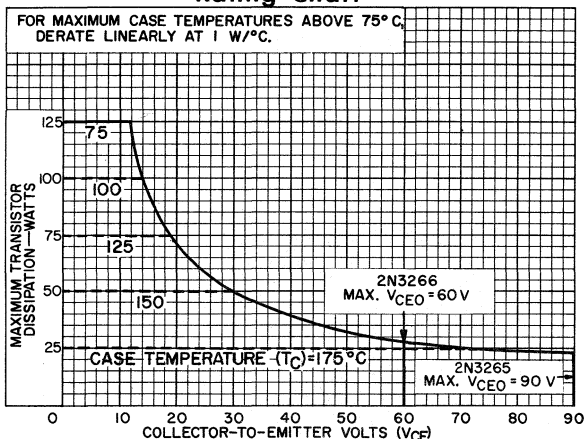
	Min.	Max.
Thermal Resistance. θ_{JC}	-	1 $^{\circ}\text{C}/\text{watt}$
Junction-to-case,		
$V_{CE} = 40$ volts,		
$I_C = 0.5$ amperes,		
$T_J = 100^{\circ}\text{C}$		



2N3265



Rating Chart



92CS-12430

RADIO CORPORATION OF AMERICA
Electronic Components and Devices

Harrison, N. J.



Power Transistor

SILICON N-P-N EPITAXIAL TYPE

High-Power, High-Speed, and High-Current Type for Switching, Amplifier, and Power Oscillator Applications in Aerospace, Military, and Industrial Equipment

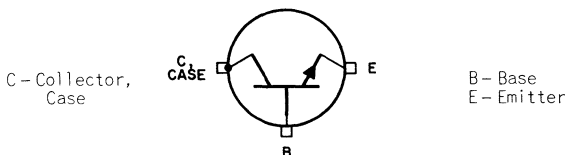
The 2N3266 is the same as the 2N3264 except for the following items:

Mechanical:

Dimensions. See accompanying *Dimensional Outline*

Terminal Diagram. . . (See accompanying *Dimensional Outline*):

TOP VIEW



Maximum Ratings, Absolute-Maximum Values:

Transistor Dissipation. . P_T See accompanying *Rating Chart*

Thermal Resistance. . . . θ_{JC} 1 max. °C/watt
Junction-to-case

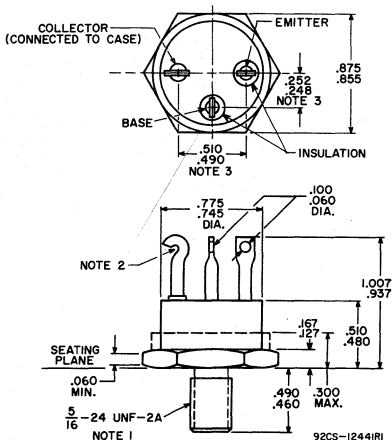
ELECTRICAL CHARACTERISTICS

Case temperature = 25° C, unless otherwise specified

	Min.	Max.	
Thermal Resistance. θ_{JC}	-	1	°C/watt
Junction-to-case, V _{CE} = 40 volts, I _C = 0.5 amperes, T _J = 100° C			



2N3266



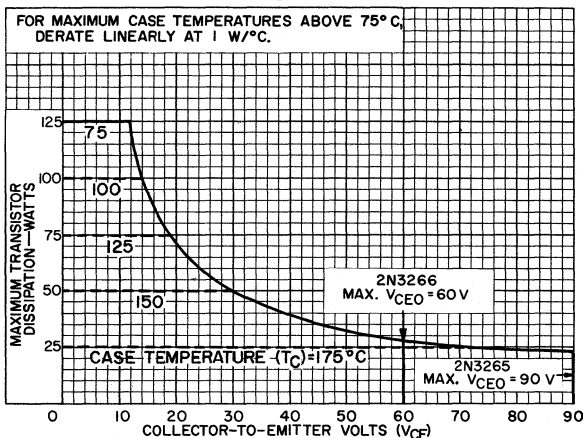
Dimensions in Inches

Note 1: Complete threads extend to within 2-1/2 threads of seating plane.

Note 2: This terminal may be hook type or flattened and pierced.

Note 3: Position of terminals with respect to the hexagon is not controlled.

Rating Chart



92CS-12430

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Transistor

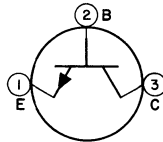
SILICON N-P-N "OVERLAY" EPITAXIAL-PLANAR TYPE

For Large-Signal, High-Power VHF-UHF Applications in Industrial and Military Communications Equipment Under Class-A, -B, or -C Amplifier, Frequency Multiplier, or Oscillator Operation

MECHANICAL

Dimensions . . . See accompanying Dimensional Outline (T0-60)
 TERMINAL DIAGRAM (Bottom View)

Pin 1 - Emitter
 Pin 2 - Base



Pin 3 - Collector

All electrodes are electrically isolated from case

ABSOLUTE-MAXIMUM RATINGS

Collector-to-Base Voltage.	V_{CB0}	65	V
Collector-to-Emitter Voltage			
$V_{BE} = -1.5$ V	V_{CEV}	65	V
Base open.	V_{CEO}	40	V
Emitter-to-Base Voltage.	V_{EB0}	4	V
Collector Current.	I_C	1.5	A
Base Current	I_B	0.2	A ←
Transistor Dissipation			
At case temperatures:			
From -65 to 25°C	P_T	11.6	W
Above 25°C	Derate linearly	0.0663 W/ $^\circ\text{C}$	
Temperature Range			
Operating (Junction)	$T(\text{opr})$	-65 to 200	$^\circ\text{C}$
Storage.	$T(\text{stg})$	-65 to 200	$^\circ\text{C}$
Pin-Soldering Temperature ^a		230	$^\circ\text{C}$
For 10 s max			

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode-voltage and electrode-current values for given test conditions are dc at case temperature = 25°C

		Min	Typ	Max	
Collector-to-Base Breakdown Voltage	BV_{CB0}	65	-	-	V
$I_C = 0.1$ mA, $I_E = 0$					
Collector-to-Emitter Breakdown Voltage					
I_C (Pulsed) = 0 to 200 mA, $V_{BE} = -1.5$ V					
	BV_{CEV}	65 ^c	-	-	V
I_C (Pulsed) = 0 to 200 mA, $I_B = 0$					
	BV_{CEO}	40 ^c	-	-	V

← Indicates a change.



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DATA 1
 6-66

2N3375

		Min	Typ	Max	
Emitter-to-Base Breakdown Voltage	BV_{EBO}	4	-	-	V
$I_E = 0.1 \text{ mA}, I_C = 0$					
Collector-to-Emitter Sustaining Voltage					
$I_C = 200 \text{ mA}, I_B = 0$	$V_{CE0(sus)}$	40	-	-	V
$I_C = 200 \text{ mA}, R_{BE} = 100 \Omega$	$V_{CER(sus)}$	40	-	-	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	-	-	1	V
$I_C = 250 \text{ mA}, I_B = 50 \text{ mA}$					
Collector-Cutoff Current					
$V_{CE} = 65 \text{ V}, V_{BE} = -1.5 \text{ V}$	I_{CEV}	-	-	1	mA
$V_{CE} = 30 \text{ V}, V_{BE} = -1.5 \text{ V}$					
$T_C = 200^\circ\text{C}$	I_{CEV}	-	-	5	mA
$V_{CE} = 30 \text{ V}, I_B = 0$	I_{CE0}	-	-	0.1	mA
Emitter-Cutoff Current	I_{EBO}	-	-	0.1	mA
$V_{EB} = 4 \text{ V}$					
DC Forward-Current Transfer Ratio					
$V_{CE} = 5 \text{ V}, I_C = 250 \text{ mA}$	h_{FE}	10	-	100	
$V_{CE} = 5 \text{ V}, I_C = 125 \text{ mA}$	h_{FE}	-	-	200	
Small-Signal Forward-Current Transfer Ratio					
$f = 100 \text{ MHz}, V_{CE} = 28 \text{ V}$					
$I_C = 125 \text{ mA}$	$ h_{fe} $	4	-	-	
Output Capacitance	C_{obo}	-	-	12	pF
$f = 1 \text{ MHz}, V_{CB} = 30 \text{ V}, I_C = 125 \text{ mA}$					
RF Power Output, Unneutralized: ^d					
Amplifier					
$f = 100 \text{ MHz}, V_{CC} = 28 \text{ V}$					
$P_{ie} = 1 \text{ W}$	P_{oe}	7.5 ^e	-	-	W
$f = 400 \text{ MHz}, V_{CC} = 28 \text{ V}$					
$P_{ie} = 1 \text{ W}$	P_{oe}	3 ^f	-	-	W
Oscillator					
$f = 500 \text{ MHz}, V_{CC} = 28 \text{ V}$	P_{oe}	-	2.5 ^g	-	W

^a Measured along pin at distances not less than 1/32 inch from ceramic wafer.

^b Pulsed through an inductor (25 mH); duty factor = .5.

^c Measured at a current where the breakdown voltage is a minimum.

^d See accompanying *Power-Output-Measurement Circuits*.

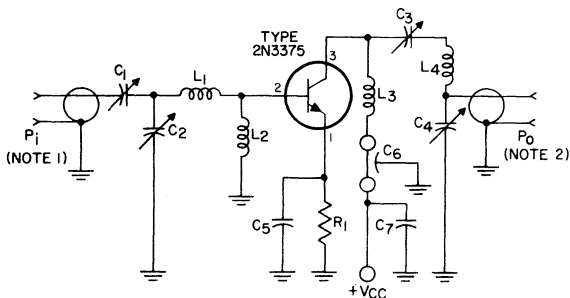
^e For conditions given, minimum efficiency, $\eta = 65$ per cent.

^f For conditions given, minimum efficiency, $\eta = 40$ per cent.

^g For conditions given, typical efficiency, $\eta = 40$ per cent.



POWER-OUTPUT MEASUREMENT CIRCUITS Unneutralized RF Amplifier, 100- & 260-Mc



92CS-12568

Note 1: Generator Impedance = 50 ohms.

Note 2: Load Impedance = 50 ohms.

For 100-Mc Operation

- C₁, C₂: 7-100 pf
- C₃, C₄: 4-40 pf
- C₅: 330 pf, disc ceramic
- C₆: 1500 pf
- C₇: 0.005 μ f, disc ceramic
- L₁: 3 turns No.16 wire, 1/4" inside diameter, 5/16" long
- L₂: Ferrite choke, Z = 750 ohms $\pm$ 20%
- L₃: 2.4- μ h choke
- L₄: 5 turns No.16 wire, 5/16" inside diameter, 7/16" long
- R₁: 1.35 ohms, non-inductive

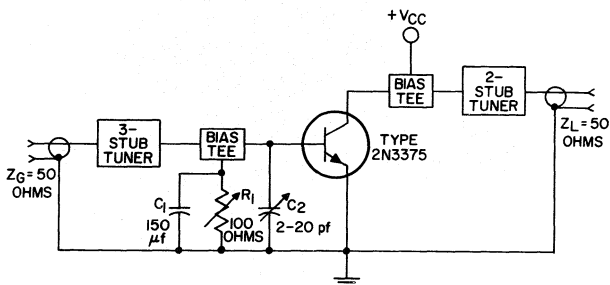
For 260-Mc Operation

- C₁: 2-25 pf
- C₂, C₃, C₄: 4-40 pf
- C₅: 50 pf, disc ceramic
- C₆: 1500 pf
- C₇: 0.005 μ f, disc ceramic
- L₁: 1 turn No.16 wire, 1/4" inside diameter, 1/8" long
- L₂: Ferrite choke, Z = 450 ohms $\pm$ 20%
- L₃: 0.47- μ h choke
- L₄: 2 turns No.16 wire, 3/8" inside diameter, 7/16" long
- R₁: 1.35 ohms, non-inductive



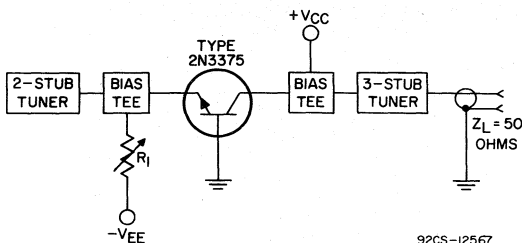
2N3375

POWER OUTPUT MEASUREMENT CIRCUITS Unneutralized RF Amplifier, 400-Mc



92CS-12566

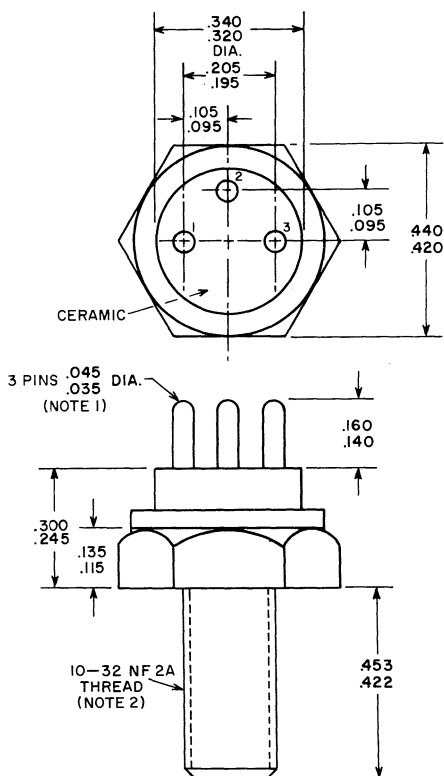
Oscillator, 500-Mc



92CS-12567

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92CS-12045R2

DIMENSIONS IN INCHES

Note 1: The pin spacing permits insertion in any socket having a pin-circle diameter of 0.200 inch and contacts which will accommodate pins having a diameter of 0.035 inch minimum, 0.045 inch maximum.

Note 2: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

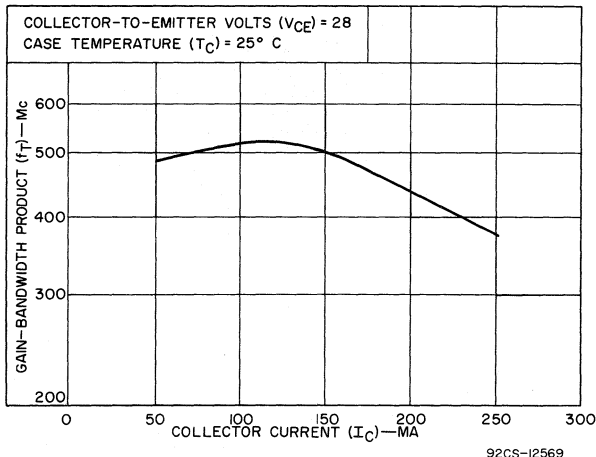
Note 3: This device may be operated in any position.



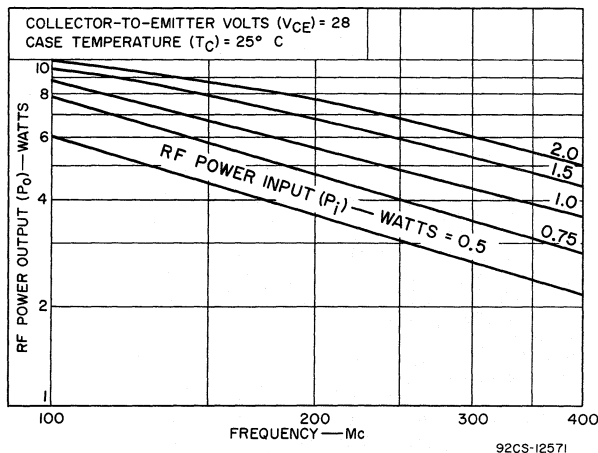
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DATA 3
6-64

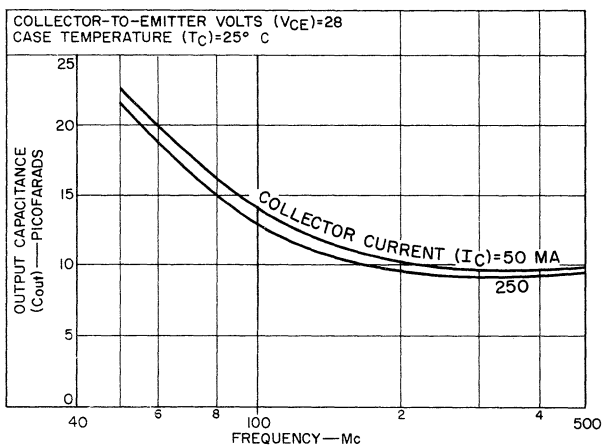
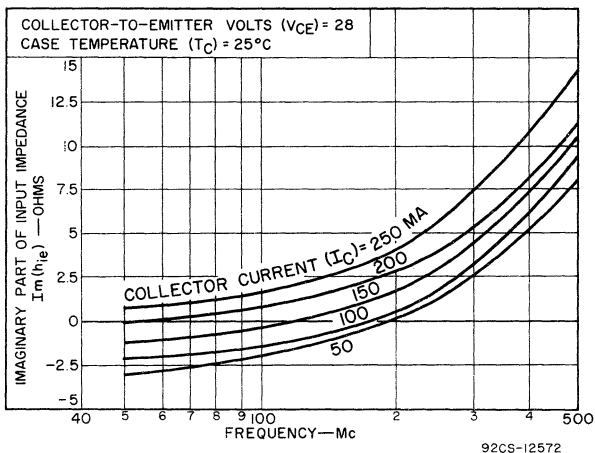
Typical Small-Signal Operation Characteristics



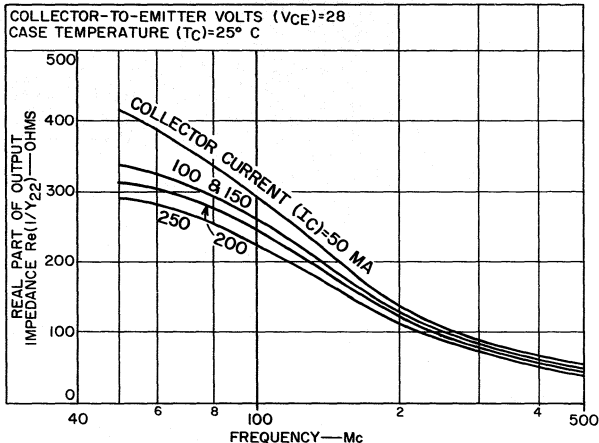
Typical Operation Characteristics



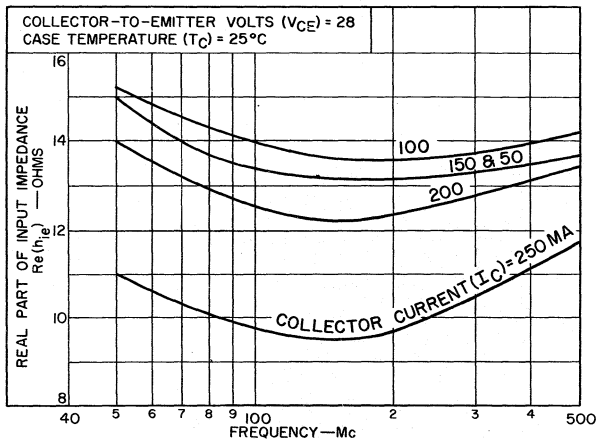
Typical Small-Signal Operation Characteristics



Typical Small-Signal Operation Characteristics



92CS-12574



92CS-12573



2N3439, 2N3440

Transistors

SILICON N-P-N TRIPLE-DIFFUSED TYPES

For High-Speed Switching and Linear-Amplifier Applications such as High-Voltage Differential and Operational Amplifiers, High-Voltage Inverters, and High-Voltage, Low-Current Switching and Series Regulators, in Military, Industrial, and Commercial Equipment

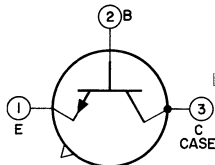
Mechanical:

Dimensions. See Outline TO-5 in General Section

Terminal Diagram

BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

Maximum Ratings, Absolute-Maximum Values:

		2N3439	2N3440
Collector-to-Base Voltage. V_{CBO}	450	300 max.	volts
With emitter open			
Collector-to-Emitter Voltage			
With reverse bias			
$V_{EB} = 1.5$ volts. V_{CEV}	450	300 max.	volts
With base open. $V_{CEO(sus)}$	350	250 max.	volts
Emitter-to-Base Voltage. V_{EBO}	7	7 max.	volts
With collector open			
Collector Current. I_C	1	1 max.	amp
Base Current. I_B	0.5	0.5 max.	amp
Transistor Dissipation:			
At case temperatures:			
From -65° to 50° C. P_T	5	5 max.	watts
Above 50° to 200° C.	Derate linearly 0.033 watt/ $^{\circ}$ C		
At free-air temperatures:			
From -65° to 50° C. P_T	1	1 max.	$^{\circ}$ C
Above 50° to 200° C.	Derate linearly 0.0066 watt/ $^{\circ}$ C		
Temperature			
Operating range			
(Junction) T_{opr}	-65 to 200		$^{\circ}$ C
Storage range. T_{stg}	-65 to 200		$^{\circ}$ C
Lead-Soldering Temperature ^a			
(For 10 sec. max.) T_L	255	255 max.	$^{\circ}$ C



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DATA 1
8-64

2N3439, 2N3440

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode-voltage and electrode-current values for given test conditions are dc; case temperature = 25° C

	2N3439	2N3440	
Collector-to-Emitter			
Sustaining Voltage . . $V_{CE(sus)}$ $I_C = 50$ ma, $I_B = 0$	350	250 min.	volts
Base-to-Emitter			
Saturation Voltage . . $V_{BE(sat)}$ $I_C = 50$ ma, $I_B = 4$ ma	1.3	1.3 max.	volts
Collector-to-Emitter			
Saturation Voltage . . $V_{CE(sat)}$ $I_C = 50$ ma, $I_B = 4$ ma	0.5	0.5 max.	volt
Collector-Cutoff Current: $I_B = 0$,			
$V_{CE} = 300$ volts . . . I_{CEO}	20	- max.	μ a
$V_{CE} = 200$ volts . . . I_{CEO}	-	50 max.	μ a
Reverse bias $V_{EB} = 1.5$ volts,			
$V_{CE} = 450$ volts . . . I_{CEV}	500	- max.	μ a
$V_{CE} = 300$ volts . . . I_{CEV}	-	500 max.	μ a
Emitter-Cutoff Current . I_{EBO}			
Reverse bias $V_{EB} = 6$ volts, $I_C = 0$	20	20 max.	μ a
Second-Breakdown Current, (Safe-Operating Region) $V_{CE} = 200$ volts			
$I_{S/b}^b$	50	50 min.	ma
DC Forward-Current			
Transfer Ratio $V_{CE} = 10$ volts,			
$I_C = 20$ ma h_{FE}	40	40 min.	
$I_C = 2$ ma h_{FE}	160	160 max.	
$I_C = 2$ ma h_{FE}	30	- min.	
Output Capacitance . . . C_{ob}			
$f = 1$ Mc, $V_{CB} = 10$ volts, $I_E = 0$	10	10 max.	pf
Small-Signal Short-Circuit Forward-Current Transfer Ratio $f = 5$ Mc, $V_{CE} = 10$ volts, $I_C = 20$ ma			
h_{fe}	4	4 min.	
Thermal Resistance . . . θ_{JC}			
Junction-to-case, $P_O = 2$ to 4 watts, $I_E = 100$ ma	30	30 max.	°C/watt

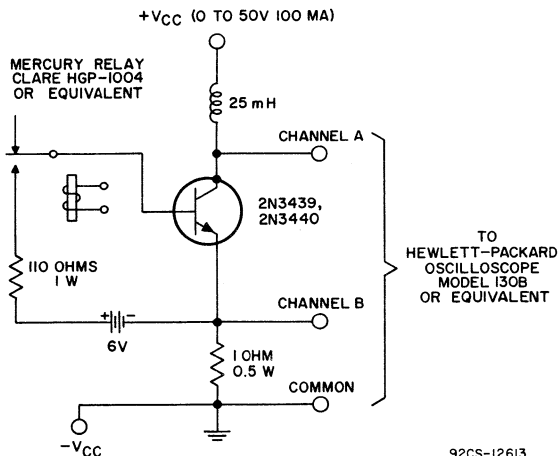
^a Measured 1/16" $\pm$ 1/32" along lead from seating plane.

^b $I_{S/b}$ is defined as the current at which second-breakdown occurs at specified collector voltage.



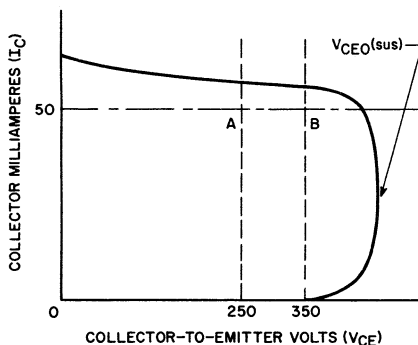
2N3439, 2N3440

CIRCUIT USED TO MEASURE SUSTAINING VOLTAGE $V_{CE0(sus)}$



92CS-12613

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF $V_{CE0(sus)}$ (Test Circuit Shown Above)



92CS-12611

The sustaining voltage $V_{CE0(sus)}$ is acceptable when the trace falls to the right and above point "A" for type 2N3440. The trace must fall to the right and above point "B" for type 2N3439.

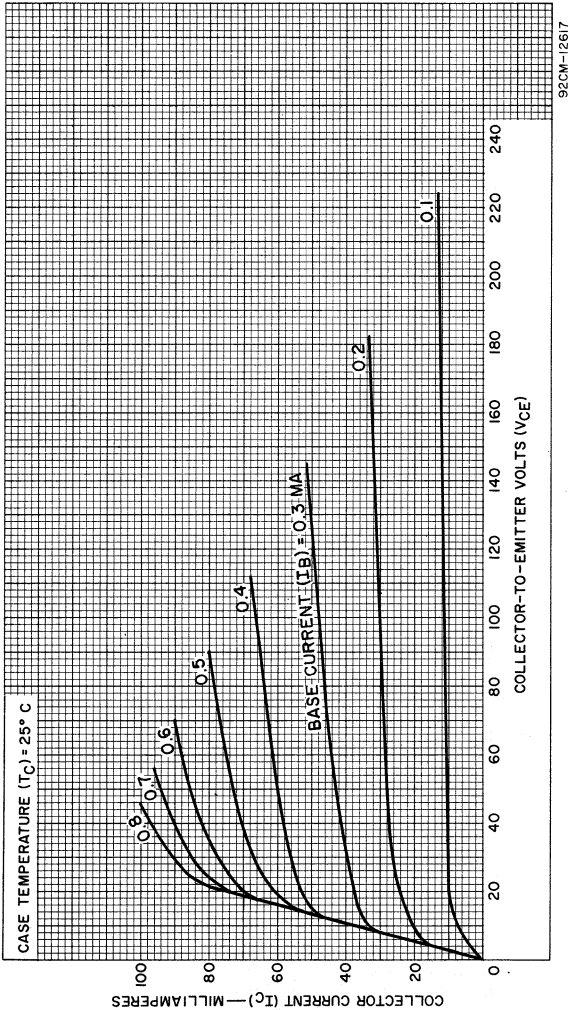


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DATA 2
8-64

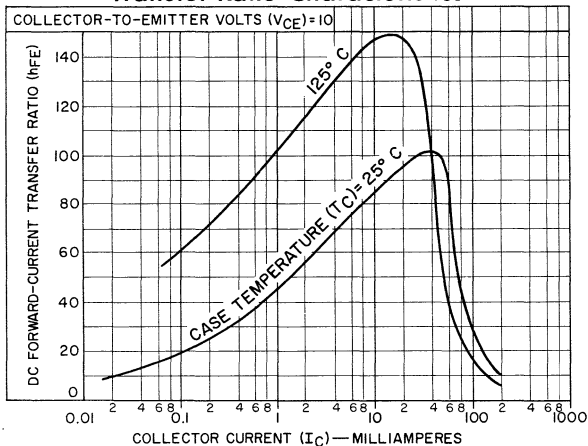
2N3439, 2N3440

Typical Collector Characteristics



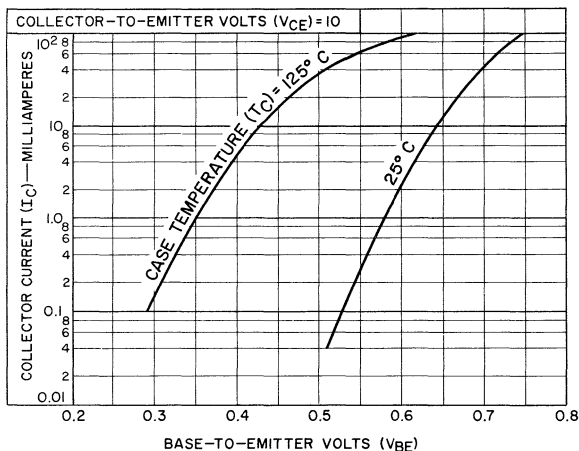
2N3439, 2N3440

Typical DC Forward-Current Transfer-Ratio Characteristics



92CS-12615

Typical Transfer Characteristics



92CS-12619



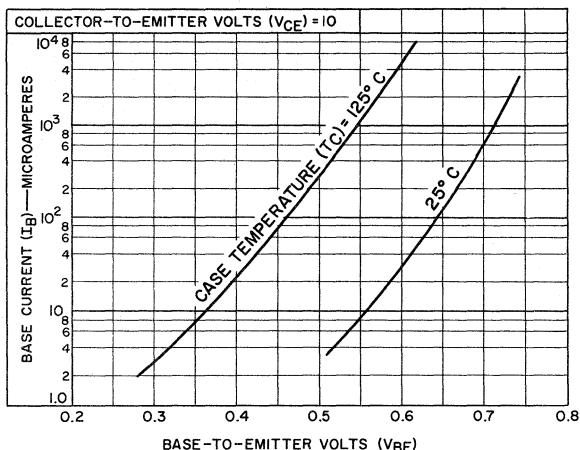
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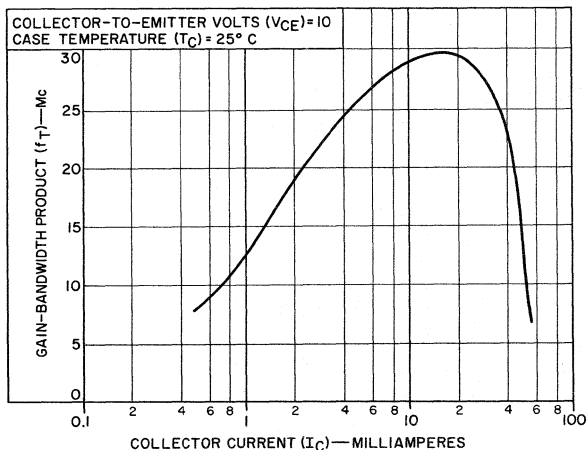
DATA 3
8-64

2N3439, 2N3440

Typical Base Characteristics



Typical Gain-Bandwidth Product Characteristic



2N3441, 2N3442

DC Forward-Current Transfer Ratio

$V_{CE} = 4$ volts,

$I_C = 0.5$ amp. . .

$I_C = 3$ amp. . . .

Thermal Resistance. .
Junction-to-case

2N3441 | 2N3442

h_{FE}	20	-	min.
h_{FE}	80	-	max.
h_{FE}	-	20	min.
h_{FE}	-	70	max.
θ_{JC}	7	1.5	max. °C/watt

^a Measured 1/16" ± 1/32" along pin from seating plane.

← Indicates a change.

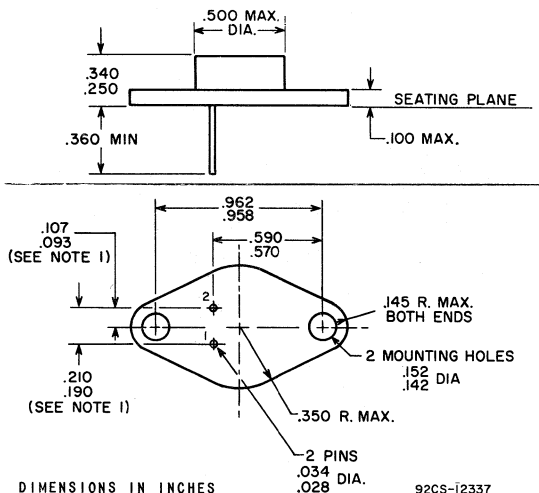


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DATA 2
2-65

2N3441, 2N3442

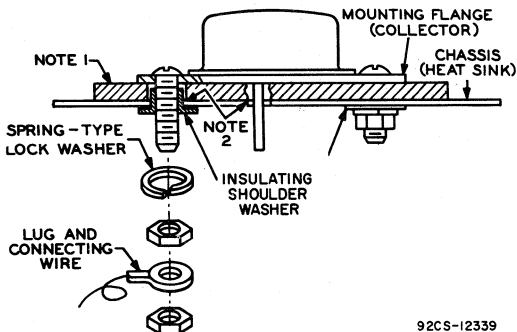
DIMENSIONAL OUTLINE FOR TYPE 2N3441 TO-66*



Note 1: These dimensions should be measured at points .050 to .055 below seating plane. When gauge is not used, measurement will be made at seating plane.

* New JEDEC number assigned for "small" TO-3 package.

SUGGESTED MOUNTING ARRANGEMENT For 2N3441 & 2N3442



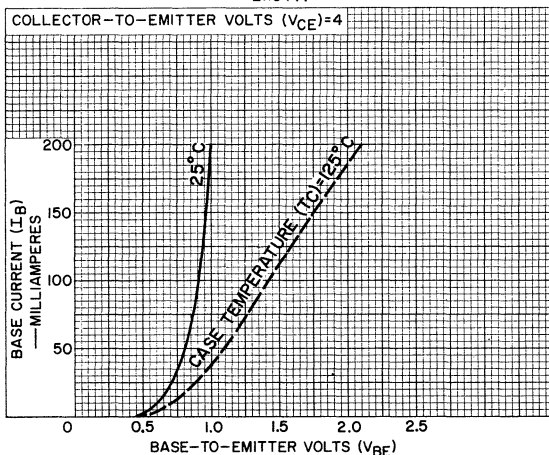
Note 1: 0.002" mica insulator or anodized aluminum insulator (drilled or punched with burrs removed).

Note 2: Remove burrs from chassis holes.

2N3441, 2N3442

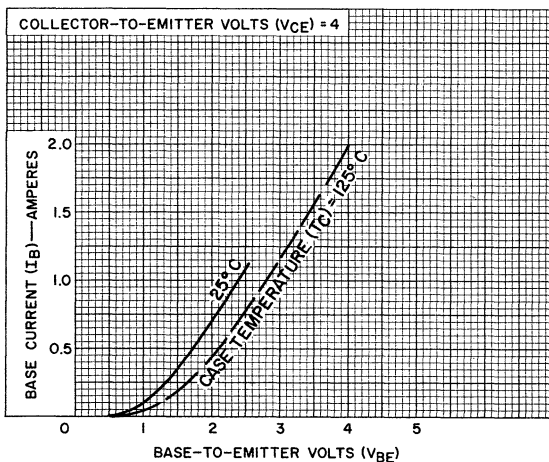
Typical Base (Input) Characteristics

2N3441



92CS-12645

2N3442



92CS-12640



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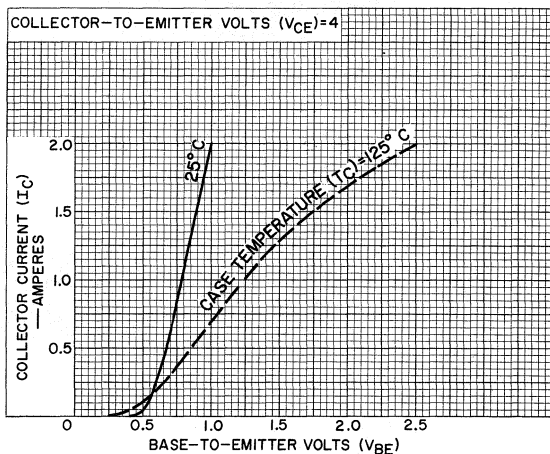
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DATA 3
8-64

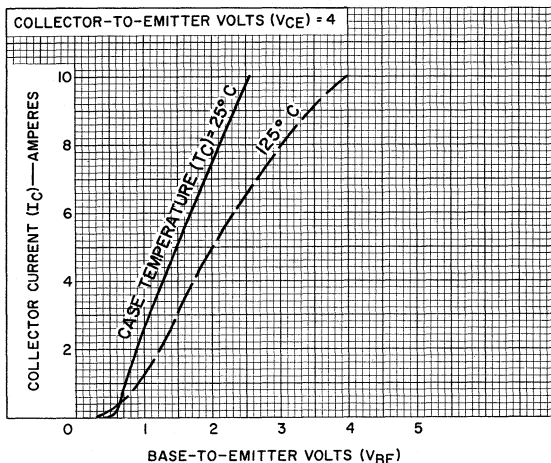
2N3441, 2N3442

Typical Transfer Characteristics

2N3441



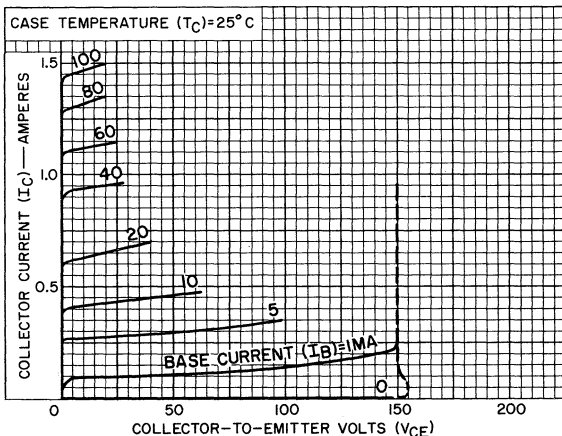
2N3442



2N3441, 2N3442

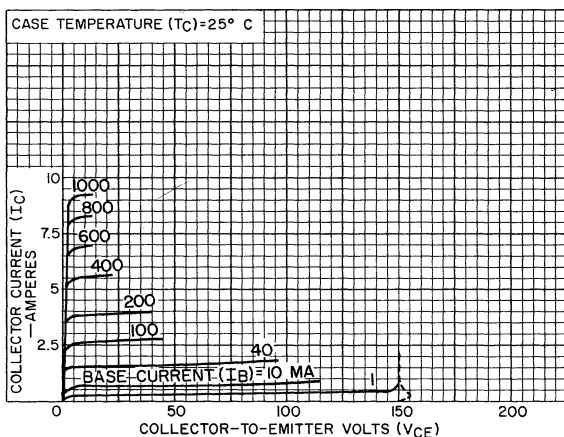
Typical Collector Characteristics

2N3441



92CS-12642

2N3442



92CS-12638



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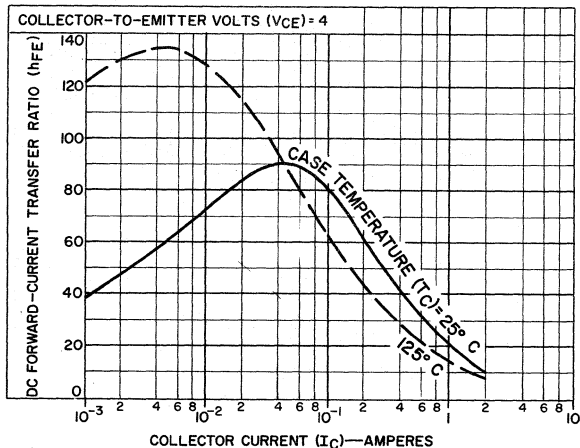
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DATA 4
8-64

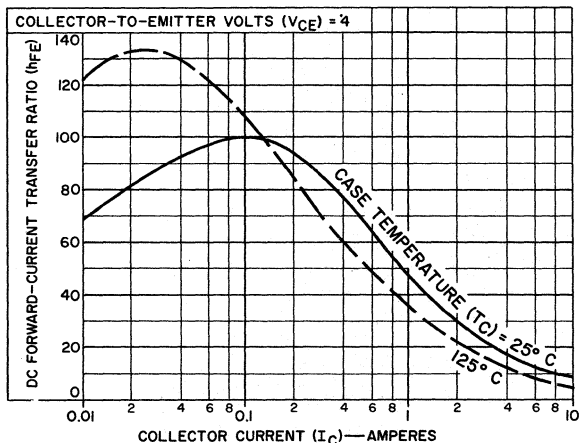
2N3441, 2N3442

Typical DC Forward-Current Transfer-Ratio Characteristics

2N3441



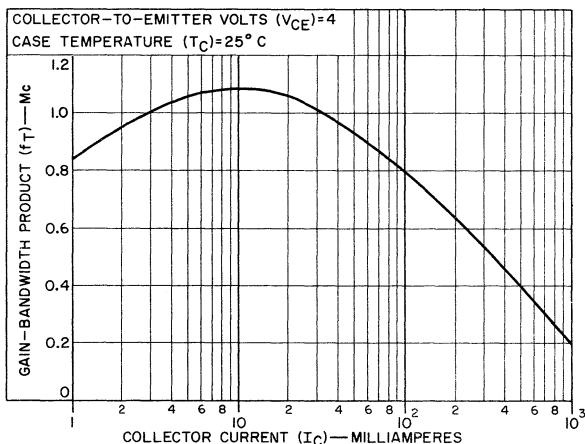
2N3442



2N3441, 2N3442

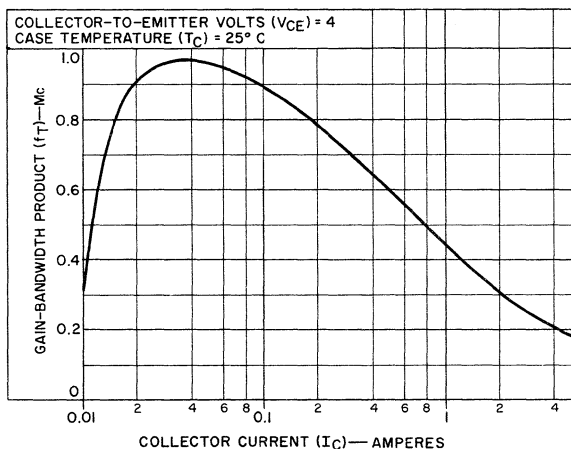
Typical Gain-Bandwidth-Product Characteristic

2N3441



92CS-12647

2N3442



92CS-12635



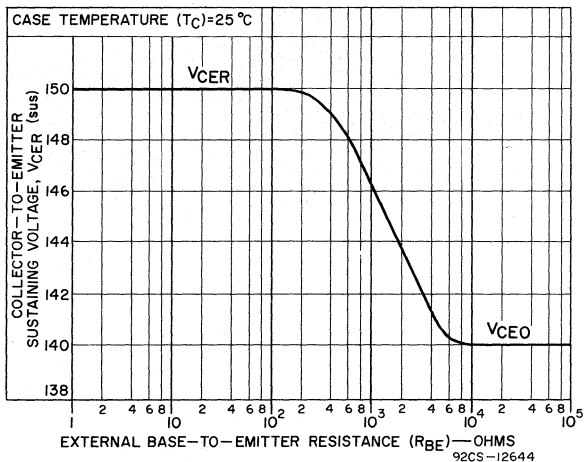
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DATA 5
8-64

2N3441, 2N3442

Typical Collector-to-Emitter Voltage Characteristics

2N3441, 2N3442

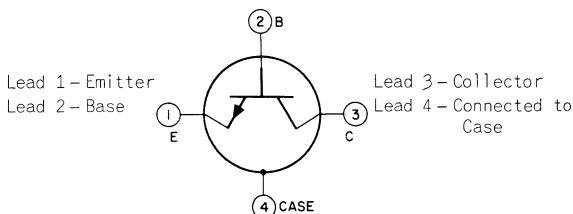


Transistor

SILICON N-P-N EPITAXIAL-PLANAR TYPE

For VHF-UHF Applications in Industrial and Commercial Equipment

Mechanical:

Dimensions See accompanying *Dimensional Outline*Terminal Diagram: **BOTTOM VIEW**Maximum Ratings, *Absolute-Maximum Values*:

Collector-to-Base Voltage. . . .	V_{CBO}	30	volts
Collector-to-Emitter Voltage . .	V_{CEO}	15	volts
Emitter-to-Base Voltage.	V_{EBO}	2	volts
Collector Current.	I_C	Limited by power dissipation	

Transistor Dissipation

At free-air temperatures:

From -65° to 25°C	P_T	200	mw
Above 25°C	Derate linearly 1.142 mw/ $^{\circ}\text{C}$		

Temperature Range

Operating (Junction).	T_{opr}	-65 to 200	$^{\circ}\text{C}$
Storage	T_{stg}	-65 to 200	$^{\circ}\text{C}$

Lead-Soldering Temperature ^a . . .	T_L	230	$^{\circ}\text{C}$
(For 10 sec. max.)			

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode-voltage and electrode-current values for given test conditions are dc; free-air temperature = 25°C

Min. Typ. Max.

Collector-to-Base Breakdown

Voltage	BV_{CBO}	30	-	-	volts
$I_C = 0.001 \text{ ma}, I_E = 0$					

Collector-to-Emitter Breakdown

Voltage	BV_{CEO}	15	-	-	volts
$I_C = 0.001 \text{ ma}, I_B = 0$					



		Min.	Typ.	Max.	
Emitter-to-Base Breakdown					
Voltage	BV_{EBO}	2	-	-	volts
$I_E = 0.001$ ma, $I_C = 0$					
Collector-Cutoff Current					
I_{CBO}		-	-	0.02	μ a
$V_{CB} = 1$ volt, $I_E = 0$					
DC Forward-Current					
Transfer Ratio	h_{FE}	25	-	150	
$V_{CE} = 8$ volts, $I_C = 2$ ma					
Output Capacitance^b					
C_{ob}		-	-	2	pf
$f = 0.140$ Mc, $V_{CB} = 8$ volts, $I_E = 0$					
Small-Signal Forward-Current Transfer Ratio^c					
h_{fe}		-	9	-	
$f = 100$ Mc, $V_{CE} = 8$ volts, $I_C = 2$ ma					
Small-Signal Power Gain					
UNNEUTRALIZED AMPLIFIER CIR- CUIT ^c - $f = 200$ Mc, $V_{CE} = 8$ volts, $I_C = 2$ ma. .					
G_{pe}		11.5	-	17	db
NEUTRALIZED AMPLIFIER CIR- CUIT ^b - $f = 470$ Mc, $R_S^d = 50$ ohms, $I_C = 1.5$ ma, $V_{CE} = 6$ volts					
G_{pe}		-	12	-	db
Noise Figure^c					
UHF - $f = 470$ Mc, $R_S = 50$ ohms, $V_{CE} = 6$ volts, $I_C = 1.5$ ma. .					
NF		-	5	-	db
VHF - $f = 200$ Mc, $I_C = 2$ ma, $V_{CE} = 8$ volts,					
NF		-	-	4.5	db
VHF - $f = 60$ Mc, $R_S^d = 400$ ohms $V_{CE} = 8$ volts, $I_C = 1$ ma. . .					
NF		-	2.5	-	db

^a Measured along lead at distances not less than $1/32"$ from seating plane.

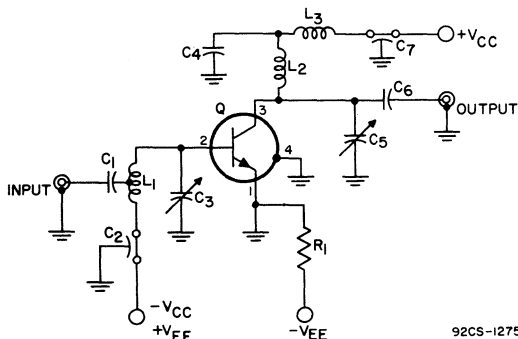
^b Lead 4 (case) not connected.

^c Lead 4 (case) grounded.

^d R_S = Source resistance.



200-MC POWER GAIN & VHF NOISE FIGURE TEST CIRCUIT Unneutralized Amplifier



Q = 2N3478

C₁, C₄ = 510 pf

C₂, C₇ = 2300 pf

C₃, C₅ = 2-25 pf

C₆ = 10 pf

R₁ = 2000 ohms

L₁ = 1/2 Turn #14 Formvar[•] center tapped, length = 2 inches

L₂ = 1/2 Turn #14 Formvar[•], length = 1-1/2 inches

L₃ = 1 μH RF choke

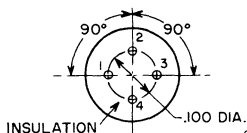
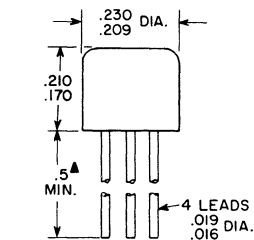
Source (Generator) Resistance

R_g = 50 ohms

Load Resistance R_L = 50 ohms

[•] Trademark, Shawindian Products Corporation.

DIMENSIONAL OUTLINE



▲ Lead No. 4 = .375 Min.

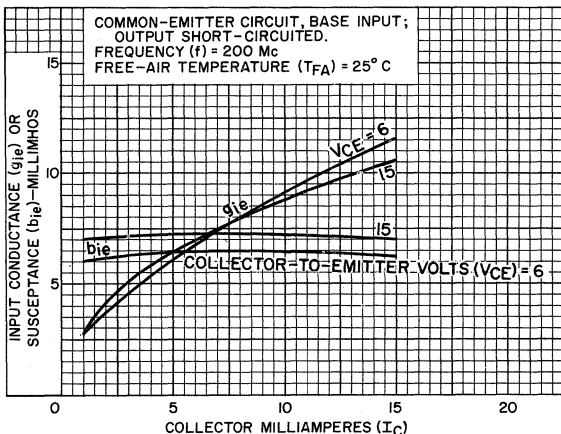
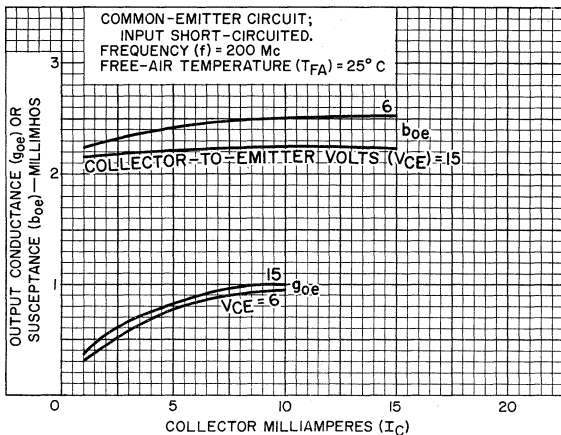
DIMENSIONS IN INCHES



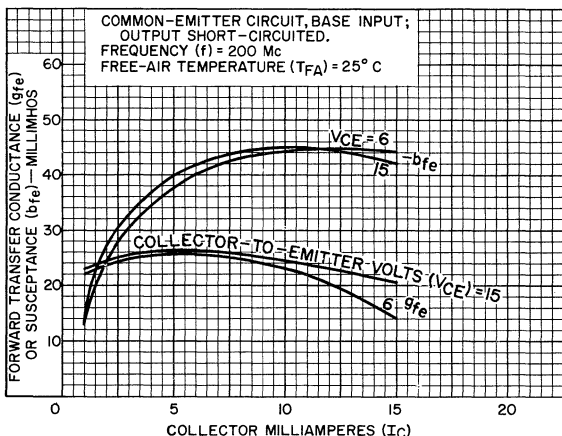
RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Harrison, N. J.

DATA 2
2-65

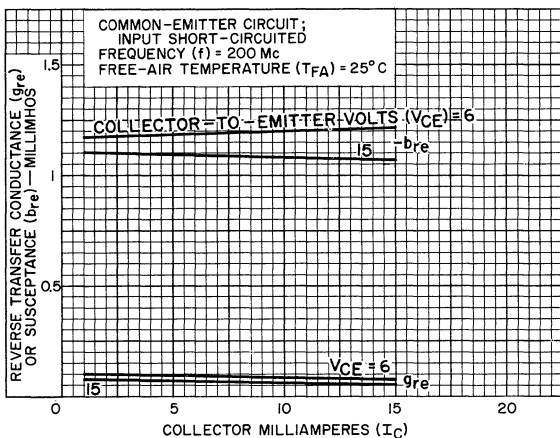
Two-Port Admittance "Y" Parameters

INPUT ADMITTANCE (y_{ie})OUTPUT ADMITTANCE (y_{oe})

Two-Port Admittance "Y" Parameters

FORWARD TRANSADMITTANCE (y_{fe})

92CS-12759

REVERSE TRANSADMITTANCE (y_{re})

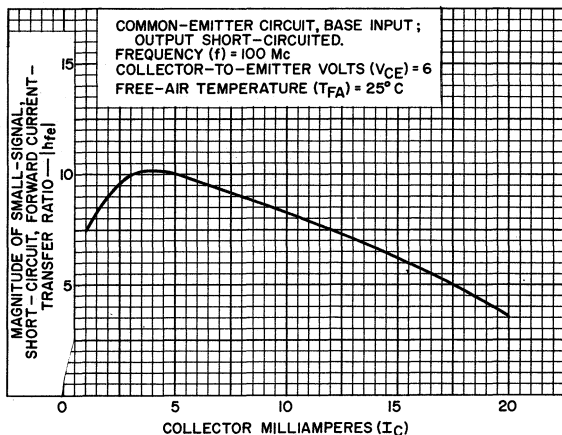
92CS-12760



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Harrison, N. J.

DATA 3
2-65

Typical Small-Signal Forward-Current Transfer-Ratio Characteristic



92CS-12756



Transistor

SILICON N-P-N DOUBLE-DIFFUSED-JUNCTION EPITAXIAL-PLANAR TYPE

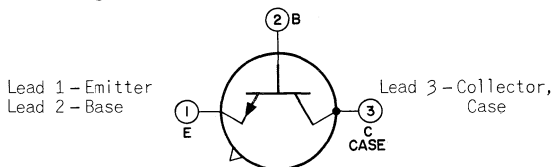
For Core-Driver and Line-Driver Service in High-Performance Computers and in Other Critical Applications Requiring Considerable Output Power

Mechanical:

Dimensions. See Outline TO-5 in General Section

Terminal Diagram

BOTTOM VIEW



SWITCHING SERVICE

Maximum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage.	V_{CBO}	60 max. volts
With emitter open		
Collector-to-Emitter Voltage	V_{CEO}	35 max. volts
With base open		
Emitter-to-Base Voltage.	V_{EBO}	5 max. volts
With collector open		
Collector Current.	I_C	Limited by power dissipation

Transistor Dissipation

At case temperatures
with heat sink:^a

From -65° to 25° C	P_T	4 max. watts
Above 25° C.		.Derate linearly 0.023 watt/°C

At free-air temperatures:

From -65° to 25° C	P_T	0.8 max. watt
Above 25° C.		.Derate linearly 0.004 watt/°C

Temperature Range

Operating (Junction)	T_{opr}	-65 to 200 °C
Storage.	T_{stg}	-65 to 200 °C

Lead-Soldering Temperature ^b	T_L	230 max. °C
(For 10 sec. max.)		

^a Measured at center of seating surface.

^b Measured along lead at distances not less than 1/32" from ceramic wafer.



ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode-voltage and electrode-current values for given test conditions are dc; case temperature = 25° C.

Min. Typ. Max.

Collector-to-Base Breakdown					
Voltage.	BV _{CBO}	60	-	-	volts
$I_C = 0.01 \text{ ma}, I_E = 0$					
Collector-to-Emitter					
Breakdown Voltage.	BV _{CEO}	35	-	-	volts
$I_C = 50 \text{ ma}, I_B = 0$					
Emitter-to-Base Breakdown					
Voltage.	BV _{EBO}	5	-	-	volts
$I_E = 0.1 \text{ ma}, I_C = 0$					
Base-to-Emitter Voltage.	V _{BE}	-	0.82	1	volt
$I_C = 150 \text{ ma}, I_B = 7.5 \text{ ma}$					
Collector-to-Emitter					
Saturation Voltage					
$I_C = 150 \text{ ma}, I_B = 7.5 \text{ ma} \dots V_{CE}(\text{sat})$		-	0.28	0.4	volt
$I_C = 500 \text{ ma}, I_B = 50 \text{ ma} \dots V_{CE}(\text{sat})$		-	0.45	1	volt
Base-Cutoff Current.	I _{BEV}	-	-	0.5	μa
$V_{CE} = 30 \text{ volts}, V_{EB} = 0.3 \text{ volt}$					
Collector-Cutoff Current					
$V_{CE} = 30 \text{ volts}, V_{EB} = 0.3 \text{ volt}:$					
$T_{FA} = 25^\circ \text{ C} \dots I_{CEV}$		-	-	0.5	μa
$T_{FA} = 100^\circ \text{ C} \dots I_{CEV}$		-	-	100	μa
DC Forward-Current					
Transfer Ratio ^c	h _{FE}	10	-	-	
$V_{CE} = 1 \text{ volt}, I_C (\text{Pulsed}) = 500 \text{ ma}$					
Output Capacitance	C _{ob}	-	5.8	10	pf
$f = 0.14 \text{ Mc}, V_{CB} = 10 \text{ volts}, I_E = 0$					
Small-Signal Short-Circuit					
Forward-Current Transfer					
Ratio.	h _{fe}	2.5	3.75	-	
$f = 100 \text{ Mc}, V_{CE} = 10 \text{ volts}, I_C = 50 \text{ ma}$					
Turn-On Time ($t_d + t_r$) ^d	t _{on}	-	16	30	nsec
$I_C = 150 \text{ ma}, I_{B1} = 15 \text{ ma}, I_{B2} = -15 \text{ ma}$					
Storage Time ^e	t _s	-	17	30	nsec
$I_C = 150 \text{ ma}, I_{B1} = 15 \text{ ma}$					
Turn-Off Time ($t_s + t_f$) ^e	t _{off}	-	27	45	nsec
$I_C = 150 \text{ ma}, I_{B1} = 15 \text{ ma}, I_{B2} = -15 \text{ ma}$					

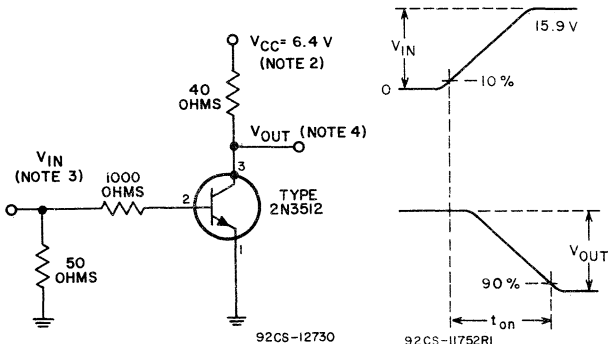
^c Pulse duration ≤ μseconds, duty factor ≤ 0.03.

^d See accompanying Circuit Used to Measure Turn-On Time (t_{on}).

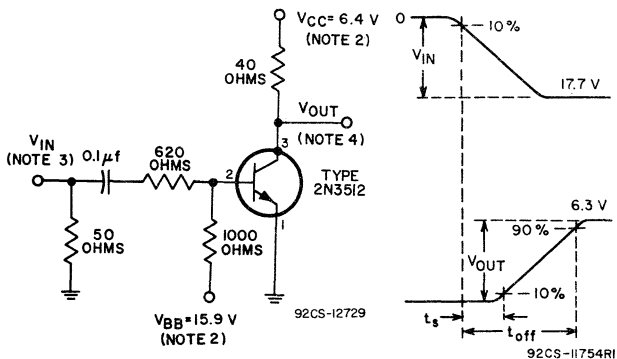
^e See accompanying Circuit Used to Measure Turn-Off Time (t_{off}) and Storage Time (t_s).



CIRCUIT USED TO MEASURE TURN-ON TIME (t_{on})



CIRCUIT USED TO MEASURE TURN-OFF TIME (t_{off}) AND STORAGE TIME (t_s)



Note 1: All resistance values have ± 1 per cent tolerance.

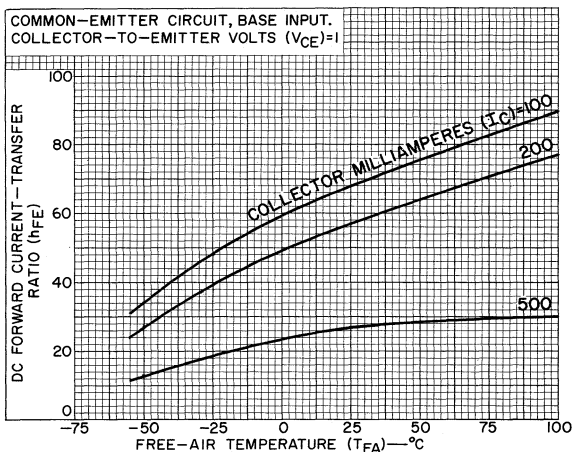
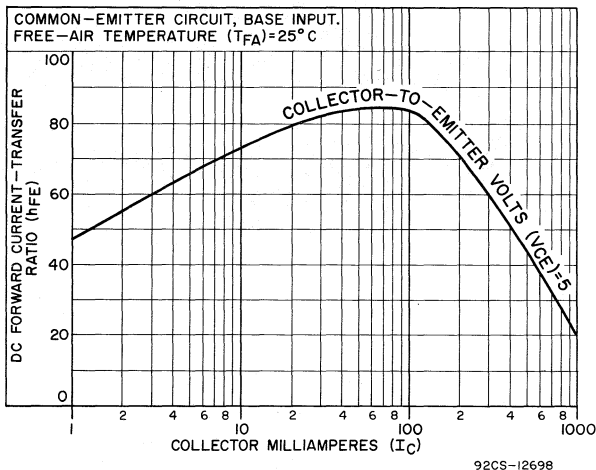
Note 2: With certain types of power supplies, it may be necessary to connect 25- μ f decoupling capacitors across the power-supply terminals for V_{CC} and V_{BB} .

Note 3: Input voltage (V_{IN}) obtained from mercury-relay type pulse generator having an output impedance of 50 ohms. V_{IN} rise time < 2 nsec; pulse duration > 150 nsec; and duty factor $< 2\%$.

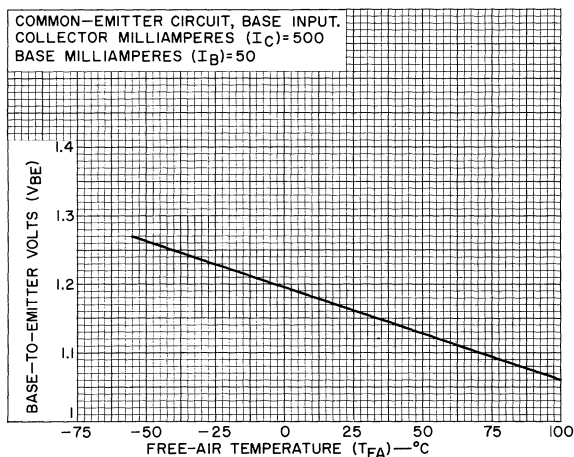
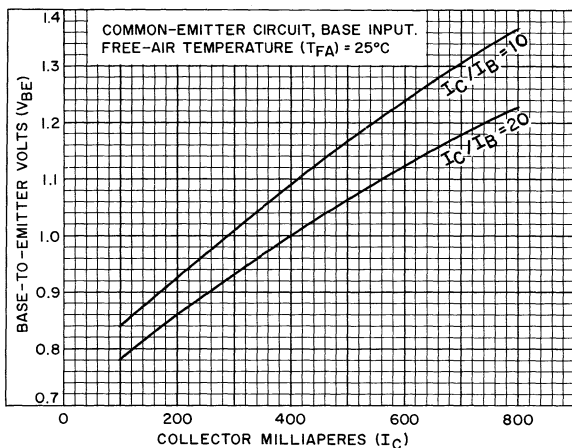
Note 4: Input and output wave forms monitored by means of a sampling oscilloscope having a rise time < 0.5 nsec; input capacitance of probe < 2.5 pf with shunt resistance of 1 megohm.



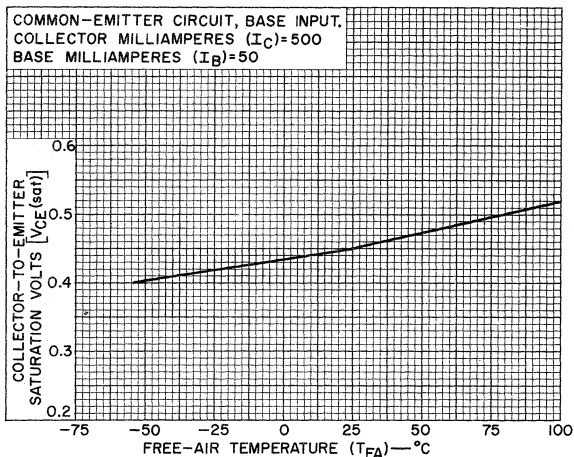
Typical DC Beta (h_{FE}) Characteristics



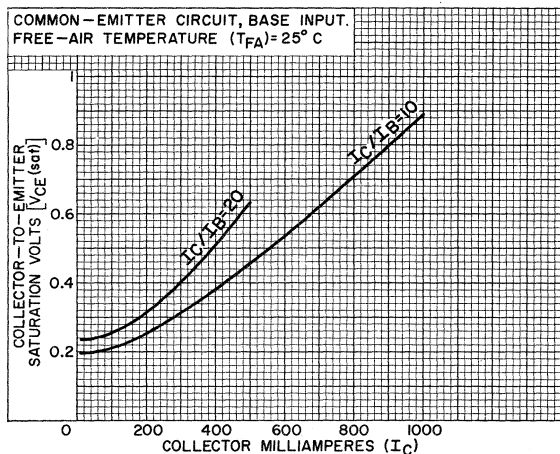
Typical Base-To-Emitter Voltage Characteristics



Typical Saturation Characteristics

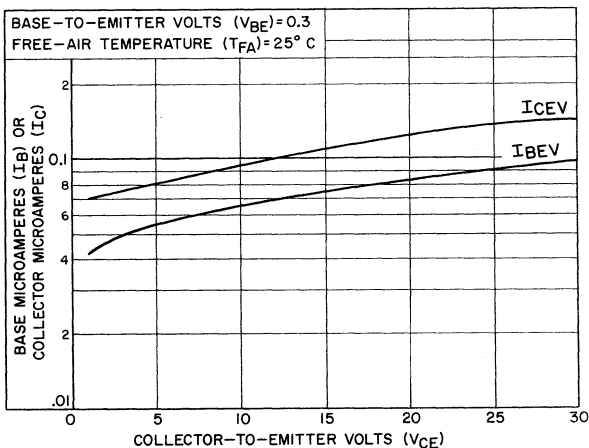


92CS-12700



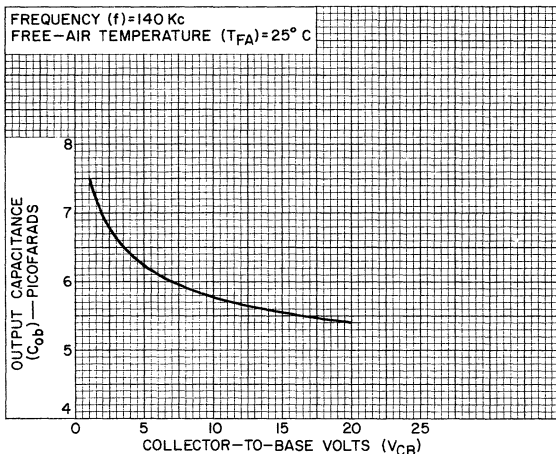
92CS-12699

Typical Cutoff-Current Characteristics



92CS-12692

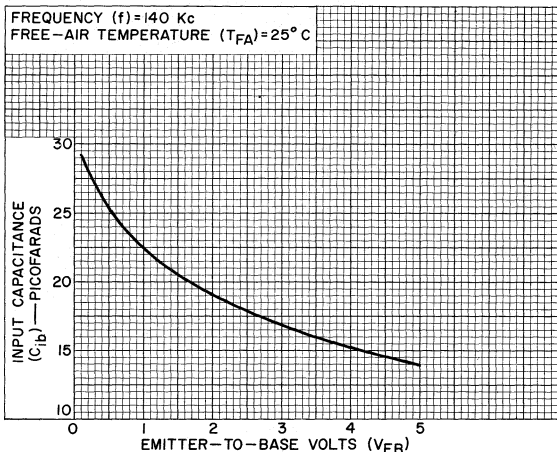
Typical Capacitance (C_{ob}) Characteristics



92CS-12704

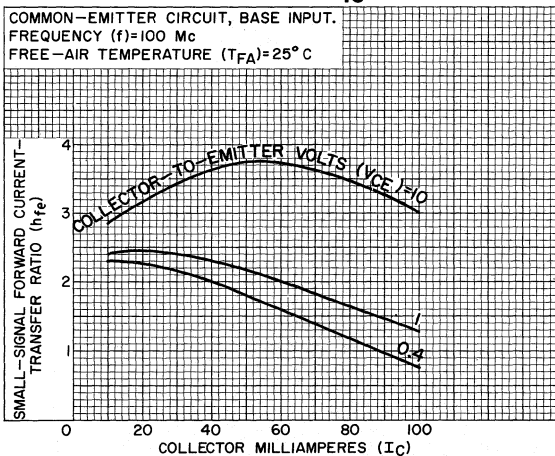


Typical Capacitance (C_{ib}) Characteristics



92CS-12705

Typical Small-Signal Beta (h_{fe}) Characteristics



92CS-12694

Silicon Controlled-Rectifier

N-P-N-P ALL-DIFFUSED, 3-JUNCTION TYPE

TO-66 PACKAGE

For Low-Cost 240-volt Line-Operated Power-Control and Power-Switching Applications

The 2N3525 is the same as the 2N3228 except for the above line operation voltage and the following items:

Maximum Ratings, Absolute-Maximum Values:

Unless otherwise specified, for sinusoidal ac supply voltage at a frequency between 50 and 400 cps, with resistive or inductive load

Peak Reverse Voltage

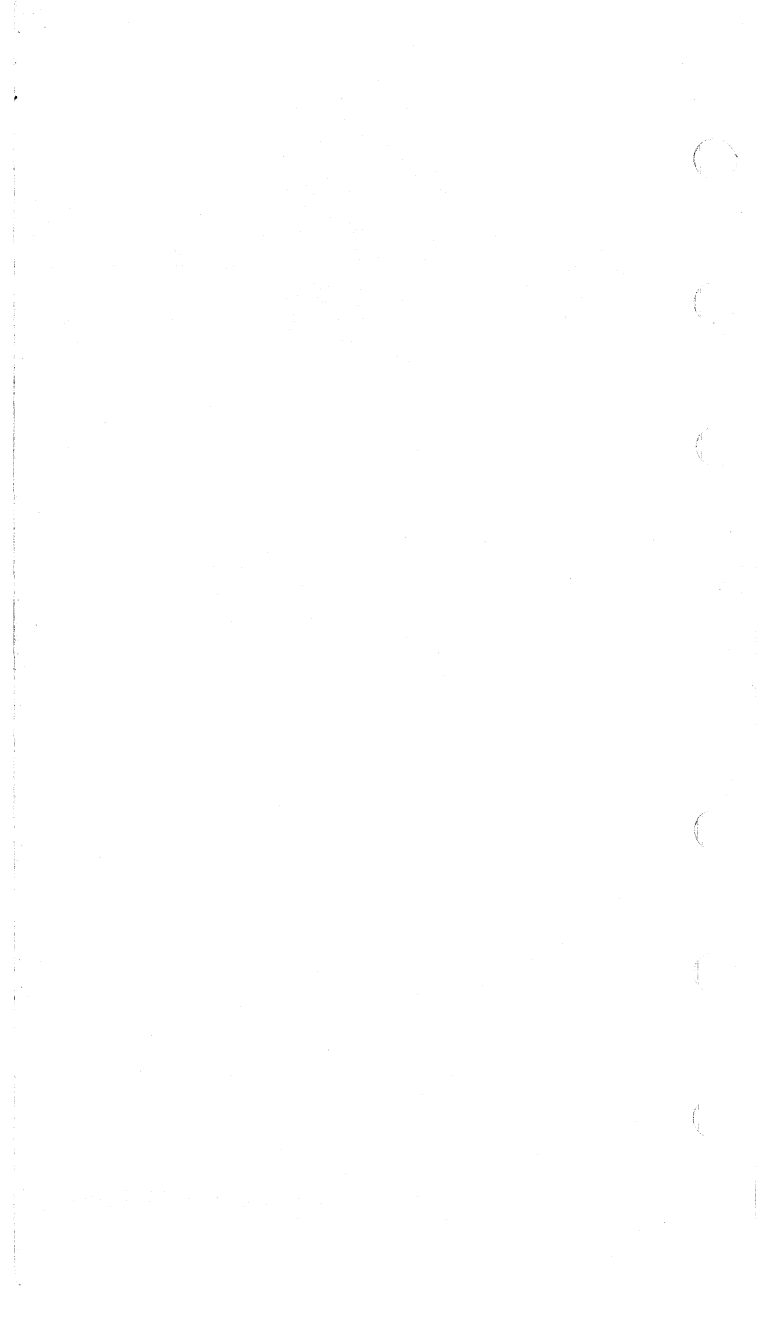
Repetitive.	$v_{RM(rep)}$	400 max.	volts
Non-repetitive (Transient) for duration of 5 milli- seconds maximum	$v_{RM(non-rep)}$	660 max.	volts

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, at maximum electrical ratings and at indicated case temperatures

		Min.	Typ.	Max.	
Forward Breakover Voltage. . .	v_{BOO}	400	-	-	volts
At $T_C = 100^\circ C$					
Peak Blocking Current					
At $T_C = 100^\circ C$, v_{FBOM} and v_{RBOM} = Rated Values:					
Forward.	I_{FBOM}	-	0.2	3	ma
Reverse.	I_{RBOM}	-	0.1	1.5	ma





2N3528, 2N3529

Silicon Controlled-Rectifiers

P-N-P-N ALL-DIFFUSED, 3-JUNCTION TYPE

For Low-Cost Line-Operated Power-Control and Power-Switching Applications

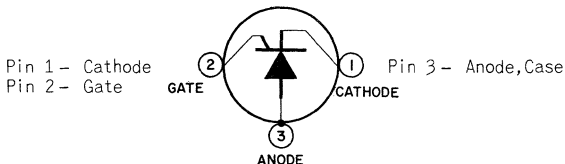
2N3528 - For 120-Volt Line Operation

2N3529 - For 240-Volt Line Operation

Mechanical:

Dimensions. See Outline TO-8 in General Section
Terminal Diagram

BOTTOM VIEW



The arrow indicates direction of forward current as indicated by dc ammeter

Maximum Ratings, Absolute-Maximum Values:

Unless otherwise specified, for sinusoidal ac supply voltage at a frequency between 50 and 400 cps, with resistive or inductive load

		2N3528	2N3529	
Peak Reverse Voltage				
With gate open:				
Repetitive.	$v_{RM}^{(rep)a}$	200	400	volts
Non-repetitive (Transient) for duration of 5 milli- seconds maximum	$v_{RM}^{(non-rep)}$	330	660	volts
Peak Forward Blocking Voltage (Repetitive). . .	$v_{FBOM}^{(rep)}$	600	600	volts
With gate open				
Average Forward Current				
At free-air temperature without heat sink from -65 to 25° C:				
DC Value at a conduction angle of 180°	I_{FAV}	1.3	1.3	amp
RMS Value	I_{FRMS}	2	2	amp
Peak Surge Current in single phase, 60 cps, resistive load operation:				
For one cycle of applied voltage	$i_{FM}^{(surge)}$	60	60	amp
For more than one cycle of applied voltage. .	$i_{FM}^{(surge)}$	See Peak-Surge- Current Rating Chart		



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DATA 1
10-64

2N3528, 2N3529

		2N3528	2N3529	
Peak Gate Voltage (With anode open):				
Forward.	v_{GKM}	10	10	volts
Reverse.	v_{KGM}	2	2	volts
Peak Forward Gate Current.	i_{GKM}	2	2	amp
Peak Gate Power.	P_{GM}	5	5	watts
Temperature Range				
Operating (Case)	T_{opr}	-40 to 100		°C
Storage.	T_{stg}	-40 to 125		°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, at maximum electrical ratings and at indicated case temperatures

		2N3528	2N3529		
Forward Breakover Voltage	v_{BOO}	200	400	min.	volts
At $T_C = 100^\circ C$					
Instantaneous Forward Voltage Drop	v_F	2.15	2.15	typ.	volts
At $i_F = 30$ amp., $T_C = 25^\circ C$	v_F	2.8	2.8	max.	volts
DC Gate-Trigger Voltage with anode at +6 volts with respect to cathode, $T_C = 25^\circ C$	V_{GT} V_{GT}	1.2 2	1.2 2	typ. max.	volts volts
Peak Blocking Current At $T_C = 100^\circ C$, v_{FBOM} and $v_{RBOM} =$ Rated Values:					
Forward.	I_{FBOM}	0.1	0.2	typ.	ma
	I_{FBOM}	1.5	3	max.	ma
Reverse.	I_{RBOM}	0.05	0.1	typ.	ma
	I_{RBOM}	0.75	1.5	max.	ma
DC Gate-Trigger Current with anode at +6 volts with respect to cathode, $T_C = 25^\circ C$	I_{GT} I_{GT}	8 15	8 15	typ. max.	ma ma
Holding Current.	i_{HOO}	12	12	typ.	ma
At $T_C = 25^\circ C$ With gate open					

OPERATING CONSIDERATIONS

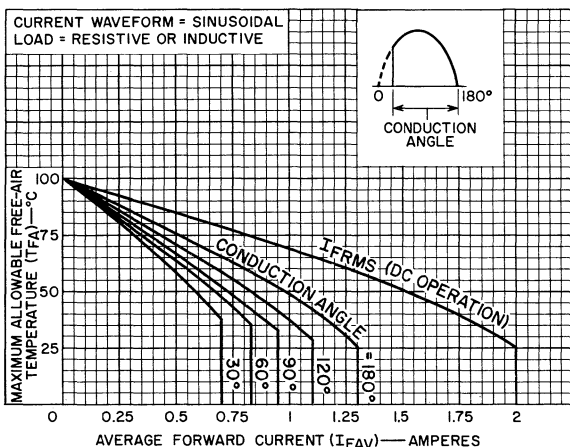
Because this rectifier may operate at voltages which are dangerous, care should be taken in the design of equipment to prevent personnel from coming in contact with the rectifier.

^a Terms, Symbols, and Definitions for the data given are shown in the General Section of the Handbook.

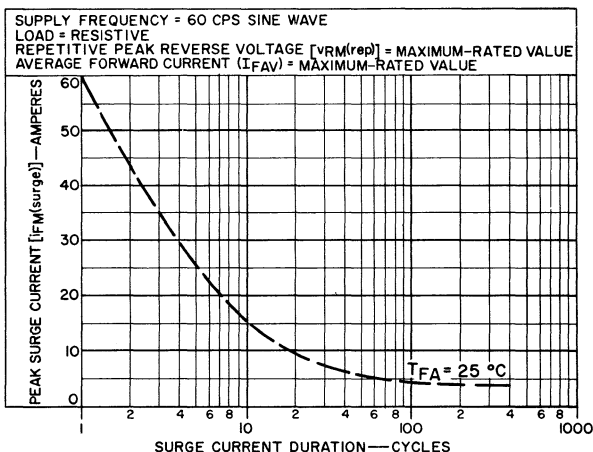


2N3528, 2N3529

Rating Chart (Free-Air Temperature)



Peak Surge Current Rating Chart

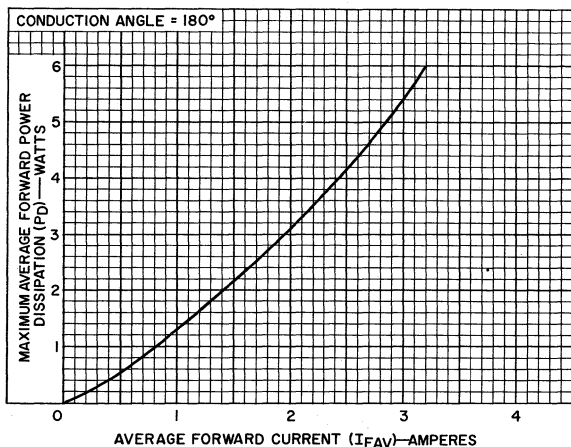


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DATA 2
10-64

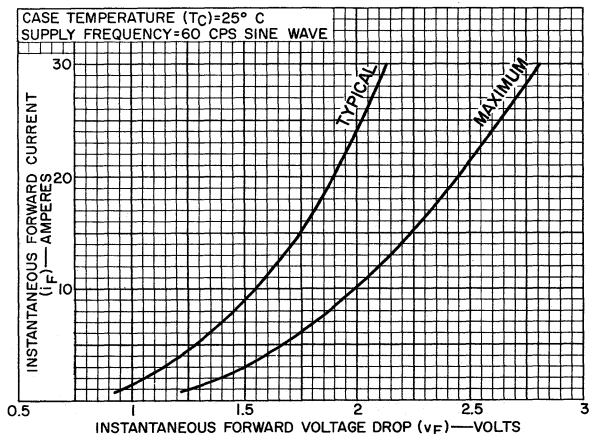
2N3528, 2N3529

Power Dissipation Chart



92CS-12750

Forward Characteristics



92CS-12379



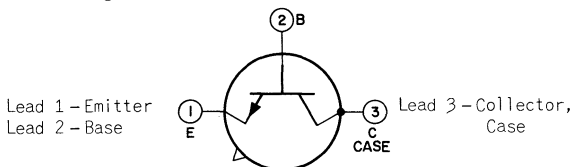
Transistor

SILICON N-P-N "OVERLAY" EPITAXIAL-PLANAR TYPE
For Large-Signal, High-Power, VHF-UHF Applications in Industrial and Military Communications Equipment for Class-A, -B, or -C Amplifier, Frequency Multiplier, or Oscillator Operation

Mechanical:

Dimensions See Outline TO-39 in General Section
 Terminal Diagram

BOTTOM VIEW

**RADIO-FREQUENCY SERVICE****Maximum Ratings, Absolute-Maximum Values:**

Collector-to-Base Voltage. V_{CBO} 65 max. volts
 With emitter open

Collector-to-Emitter Voltage

With $V_{BE} = -1.5$ volts V_{CEV} 65 max. volts
 With base open V_{CEO} 40 max. volts

Emitter-to-Base Voltage. V_{EBO} 4 max. volts
 With collector open

Collector Current. I_C 1 max. amp

Transistor Dissipation

At case temperatures:

From -65° to 25° C P_T 7 max. watts
 Above 25° C Derate linearly
 0.040 watt/ $^{\circ}$ C

Temperature Range

Operating (Junction) T_{opr} -65 to 200 $^{\circ}$ C

Storage. T_{stg} -65 to 200 $^{\circ}$ C

Lead-Soldering Temperature T_L 230 max. $^{\circ}$ C
 (For 10 sec. max.)^a

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode-voltage and electrode-current values for given test conditions are dc; case temperature = 25° C

Min. Typ. Max.

Collector-to-Base Breakdown

Voltage. BV_{CBO} 65 - - volts
 $I_C = 0.3$ ma, $I_E = 0$



Min. Typ. Max.

Collector-to-Emitter

Breakdown Voltage

I_C (Pulsed) = 0 to 200 ma,^b

$V_{BE} = -1.5$ volts.

BV_{CEV} 65^c - - volts

I_C (Pulsed) = 0 to 200 ma,^b

$I_B = 0$

BV_{CEO} 40^c - - volts

Emitter-to-Base

Breakdown Voltage.

$I_E = 0.1$ ma, $I_C = 0$

BV_{EBO} 4 - - volts

Collector-to-Emitter

Saturation Voltage. $V_{CE(sat)}$

$I_C = 250$ ma, $I_B = 50$ ma

- - 1 volt

Collector-Cutoff Current

$V_{CE} = 30$ volts, $I_B = 0$

I_{CEO} - - 0.1 ma

Base-Spreading Resistance.

$f = 100$ Mc, $V_{CE} = 28$ volts,

$I_C = 100$ ma

r_{bb} - 12 - ohms

Output Capacitance

$f = 1$ Mc, $V_{CB} = 30$ volts,

$I_E = 0$

C_{ob} - - 10 pf

Gain-Bandwidth Product

$V_{CE} = 28$ volts, $I_C = 100$ ma

f_T - 500 - Mc

RF Power Output:

Amplifier Unneutralized^d

$f = 175$ Mc, $V_{CE} = 28$ volts,

$P_i = 0.25$ watt

P_o 2.5^e - - watts

Oscillator^d

$f = 500$ Mc, $V_{CE} = 28$ volts.

P_o - 1.5^f - watts

^a Measured along lead at distances not less than 1/32" from ceramic wafer.

^b Pulsed through an inductor (25 mh); duty factor = .5.

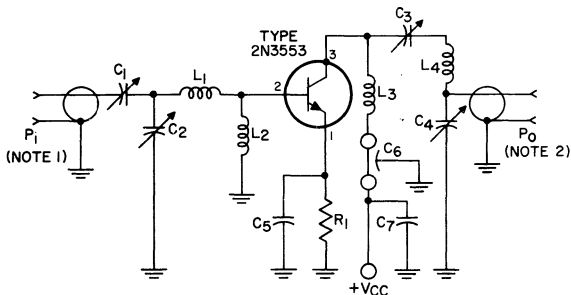
^c Measured at a current where the breakdown voltage is a minimum.

^d See accompanying *Power-Output-Measurement Circuits*.

^e For conditions given, minimum efficiency = 50 per cent.

^f For conditions given, typical efficiency = 30 per cent.

POWER-OUTPUT MEASUREMENT CIRCUITS Unneutralized RF Amplifier, 50- & 175-Mc



92CS-12800

Note 1: Generator Impedance = 50 ohms.

Note 2: Load Impedance = 50 ohms.

For 50-Mc Operation

- C_1, C_2 : 24-200 pf
- C_3 : 32-250 pf
- C_4 : 7-100 pf
- C_5 : 1,800 pf, disc ceramic
- C_6 : 2,000 pf
- C_7 : 0.01 μ f, disc ceramic
- L_1 : 5 turns No.16 wire, 1/4" ID, 1/2" long
- L_2 : Ferrite choke, $Z = 450$ ohms
- L_3 : 7- μ h choke
- L_4 : 6 turns No.20 wire on 3/8" coil form (slug-tuned). 1-1/8" long
- R_1 : 1.35 ohms, non-inductive (emitter grounded for 13.5-volt operation)

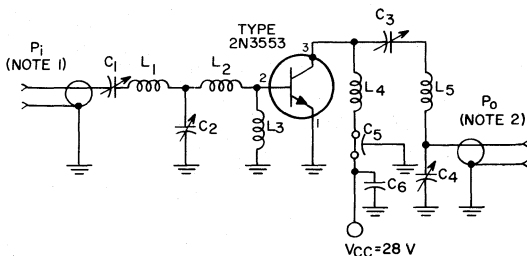
For 175-Mc Operation

- $C_1, C_2, C_3, \& C_4$: 3-35 pf
- C_5 : Not used
- C_6 : 1,000 pf
- C_7 : 0.005 μ f, disc ceramic
- L_1 : 2 turns No.16 wire, 3/16" ID, 1/4" long
- L_2 : Ferrite choke $Z = 450$ ohms
- L_3 : 2 turns No.16 wire, 1/4" ID, 1/4" long
- L_4 : 4 turns No.16 wire, 3/8" ID, 3/8" long
- R_1 : Not used (emitter connected to ground)



2N3553

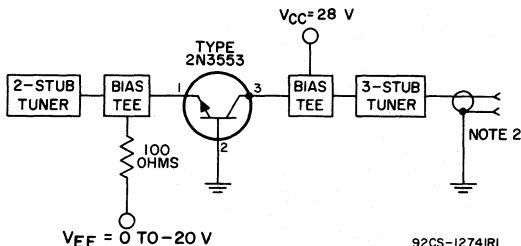
POWER OUTPUT MEASUREMENT CIRCUITS Unneutralized RF Amplifier, 260 - Mc



92CS-12740R1

- | | |
|--|---|
| C_1, C_4 : 1.5-20 pf | L_2 : 3/16" wide copper strip, 7/16" long |
| C_2, C_3 : 3-35 pf | L_3 : Ferrite choke, $Z = 450$ ohms |
| C_5 : 1,000 pf | L_4 : 1/2 turn 3/16" wide copper strip, 1/4" ID |
| C_6 : 0.005 μ f disc ceramic | L_5 : 2 turns 3/16" wide copper strip, 1/4" ID, 1/2" long |
| L_1 : 4 turns No.16 wire, 3/8" ID, 3/8" long | |

Oscillator, 500-Mc



92CS-12741R1

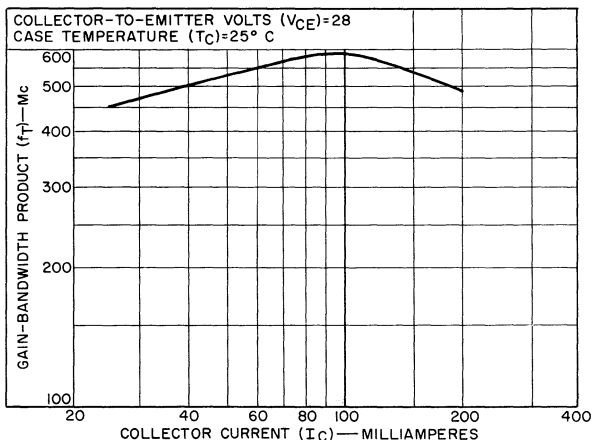
Note 1: Generator Impedance = 50 ohms.

Note 2: Load Impedance = 50 ohms.

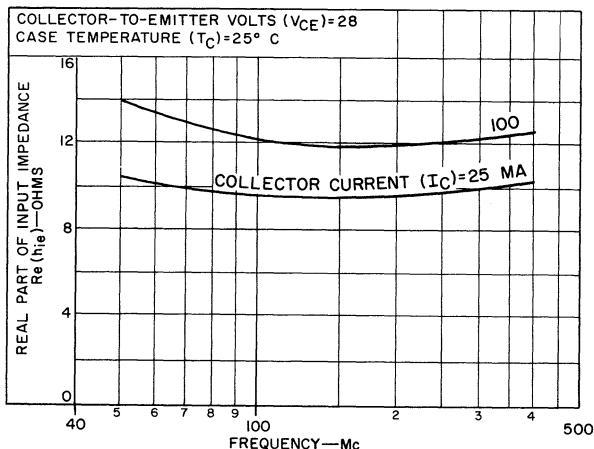
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Typical Small-Signal Operation Characteristics



92CS-12731

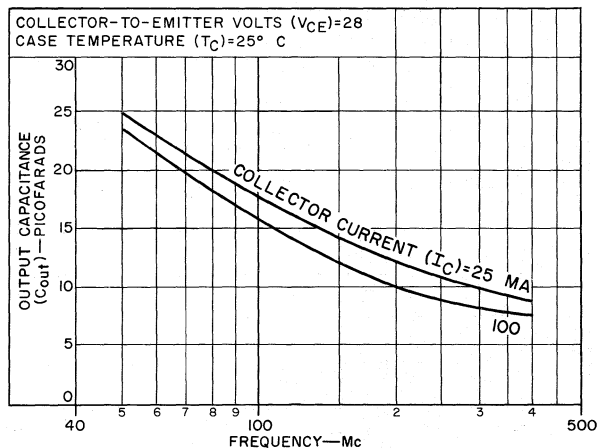
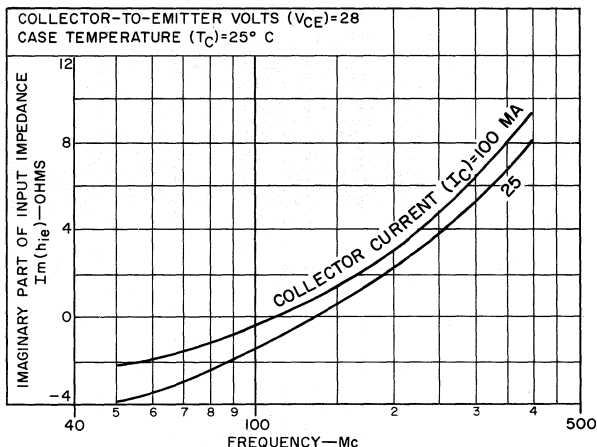


92CS-12732

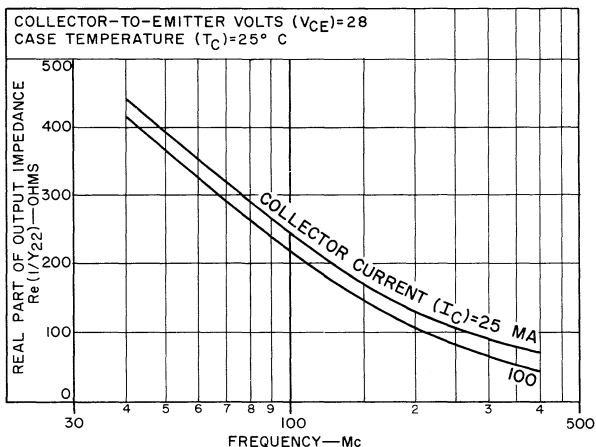


2N3553

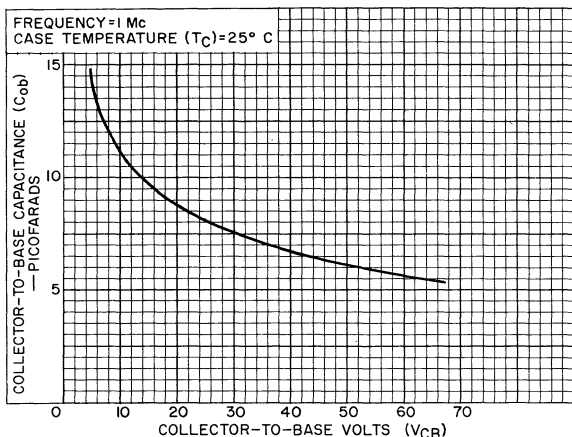
Typical Small-Signal Operation Characteristics



Typical Small-Signal Operation Characteristic



Variation of Collector-to-Base Capacitance





2N3583, 2N3584, 2N3585

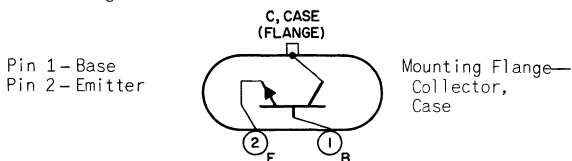
Transistors

SILICON N-P-N TRIPLE-DIFFUSED TYPES

For High-Speed Switching and Linear-Amplifier Applications such as High-Voltage Operational Amplifiers, High-Voltage Switches, Switching Regulators, Converters, Inverters, Deflection- and Hi-Fi Amplifiers, in Military, Industrial and Commercial Equipment

Mechanical:

Dimensions See Outline TO-66 in General Section
Terminal Diagram: **BOTTOM VIEW**



Maximum Ratings, Absolute-Maximum Values:

	2N3583	2N3584	2N3585	
Collector-to-Base Voltage V_{CBO}	250	375	500	volts
Collector-to-Emitter Voltage $V_{CEO(sus)}$	175	250	300	volts
Emitter-to-Base Voltage V_{EBO}	6	6	6	volts
Collector Current I_C	2	2	2	amp
Peak Collector Current	5	5	5	amp
Base Current I_B	1	1	1	amp
Transistor Dissipation P_T	See Dissipation Derating Curve			
Operating Temperature Range T_{opr}	-65 to 200			°C
Pin-Soldering Temperature ^a T_P	255	255	255	°C
(For 10 sec. max.)				

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode-voltage and electrode-current values for given test conditions are dc at case temperature = 25°C

	2N3583	2N3584	2N3585	
Collector-to-Emitter Sustaining Voltage				
With base open, $I_C =$				
200 ma, $I_B = 0$ $V_{CEO(sus)}$	175 ^b	250 ^b	300 ^b	min. volts
$R_{BE} = 50$ ohms, $I_C = 500$ ma $V_{CER(sus)}$	250 ^b	300 ^b	400 ^b	min. volts



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DATA 1
2-65

2N3583, 2N3584, 2N3585

	2N3583	2N3584	2N3585		
Base-to-Emitter					
Saturation Voltage $V_{BE(sat)}$	1.4	1.4	1.4	max.	volts
$I_C = 1 \text{ amp,}$					
$I_B = 100 \text{ ma}$					
Collector-to-Emitter					
Saturation Voltage $V_{CE(sat)}$	-	0.75	0.75	max.	volt
$I_C = 1 \text{ amp,}$					
$I_B = 125 \text{ ma}$					
Collector-Cutoff					
Current					
$V_{CE} = 150 \text{ volts,}$					
$I_B = 0 \dots \dots$	I_{CEO}	10	5	5	max. ma
$V_{BE} = -1.5 \text{ volts,}$					
$V_{CE} = 225 \text{ volts.}$	I_{CEV}	1	-	-	max. ma
$V_{CE} = 300 \text{ volts.}$	I_{CEV}	-	1	-	max. ma
$V_{CE} = 400 \text{ volts.}$	I_{CEV}	-	-	1	max. ma
$V_{CE} = 225 \text{ volts,}$					
$T_C = 200^\circ\text{C} \dots$	I_{CEV}	5	-	-	max. ma
$V_{CE} = 300 \text{ volts,}$					
$T_C = 200^\circ\text{C} \dots$	I_{CEV}	-	5	5	max. ma
Emitter-Cutoff					
Current					
$V_{BE} = 6 \text{ volts,}$	I_{EBO}	5	0.5	0.5	max. ma
$I_C = 0$					
DC Forward-Current					
Transfer Ratio					
$V_{CE} = 10 \text{ volts,}$					
$I_C = 100 \text{ ma} \dots$	h_{FE}	40	40	40	min.
$V_{CE} = 10 \text{ volts,}$					
$I_C = 1 \text{ ampere} \dots$	h_{FE}	10	25	25	min.
	h_{FE}	-	100	100	max.
Small-Signal,					
Forward Current					
Transfer Ratio.					
$V_{CE} = 10 \text{ volts,}$	h_{fe}	2	2	2	min.
$I_C = 200 \text{ ma,}$					
$f = 50 \text{ mc}$					
Second-Breakdown^c					
Collector Current					
With base forward	$I_{S/b}^d$	250	250	250	min. ma
biased, ^e					
$V_{CE} = 100 \text{ volts}$					
Second-Breakdown^c					
Energy.					
With base reverse	$E_{S/b}^f$	50	200	200	min. μJ
biased,					
$R_{BE} = 20 \text{ ohms,}$					
$L = 100 \mu\text{h,}$					
$V_{BE} = -4 \text{ volts}$					
Output Capacitance					
$f = 1 \text{ Mc, } V_{CB} = 10$	C_{ob}	120	120	120	max. pf
$\text{volts, } I_E = 0$					



		2N3583	2N3584	2N3585	
Saturated Switch Turn-On Time ($t_d + t_r$).	t_{on}	-	2	2	max. μsec
$V_{CC} = 30$ volts, $I_C = 1$ ampere, $I_B = 100$ ma					
Storage Time.	t_s	-	3	3	max. μsec
$V_{CC} = 30$ volts, $I_C = 1$ ampere, $I_B = 100$ ma					
Fall Time	t_f	-	2	2	max. μsec
$V_{CC} = 30$ volts, $I_C = 1$ ampere, $I_B = 100$ ma					
Thermal Resistance.	θ_{JC}	5	5	5	max. $^{\circ}\text{C}/\text{w}$
Junction-to-case, $I_C = 500$ ma					

- a Measured $1/16" \pm 1/32"$ along pin from seating plane.
- b **CAUTION:** The sustaining voltages $V_{CEO(sus)}$ and $V_{CER(sus)}$ **MUST NOT** be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in *Test Circuit Used to Measure Sustaining Voltages*.
- c Safe-operating region for second breakdown is explained under OPERATING CONSIDERATIONS definition.
- d IS/b is defined as the current at which second breakdown occurs at a specified collector voltage.
- e Specified value of IS/b for given value of V_{CE} as base voltage is increased from zero in a positive direction.
- f ES/b is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $ES/b = 1/2 LI^2$, where L is a series load or leakage inductance and I is the peak collector current from *Reverse-Bias, Second-Breakdown Characteristics*.

OPERATING CONSIDERATIONS

Second breakdown (S/b) occurs in all high-frequency power transistors within the linear power derating curves. This breakdown phenomenon occurs when the output impedance changes instantaneously from a large positive value to a negative value and then to a final small positive value. In general, the severity of S/b increases with both an increase in frequency response of the transistor and with an increase in the operating collector-to-emitter voltage. Repeated operation of the transistor in the S/b region will degrade and damage the transistor.

The energy required to induce S/b when the emitter-to-base junction is open, shorted, or reverse biased is much lower than that required in the forward-bias mode. The *Reverse-Bias, Second-Breakdown Characteristics* curves are recommended for circuit designs having inductance loads (such as solenoids, relays, deflection yokes, and switching regulators) where protective zener diodes are not employed across the collector junction, and in circuits where some leakage induction is present (such as in inverters, converters, and in power amplifiers).

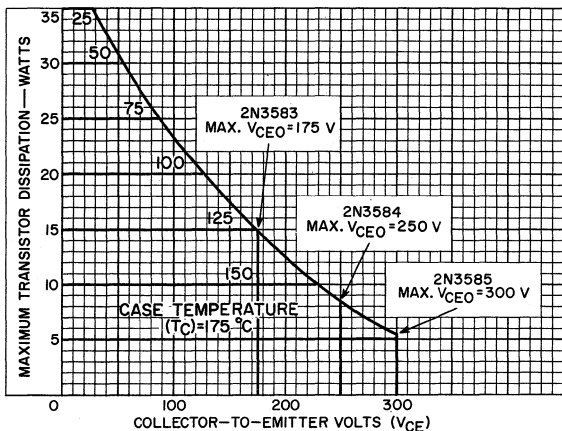
Dissipation Derating Curve shows maximum dissipation as a function of collector-to-emitter voltage for the useful case-temperature range.



2N3583, 2N3584, 2N3585

Dissipation Derating Curve

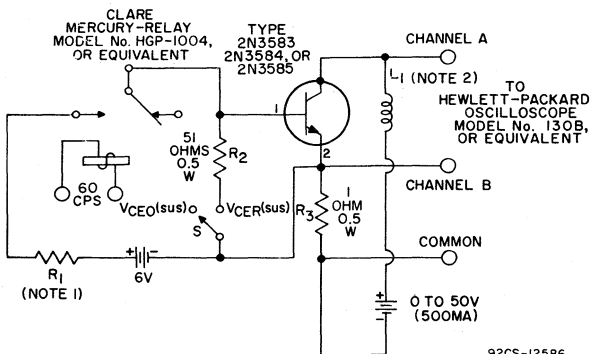
2N3583, 2N3584, & 2N3585



92CS-12878

SUSTAINING VOLTAGE TEST CIRCUIT

V_{CE0(sus)} & V_{CER(sus)}
2N3583, 2N3584, & 2N3585



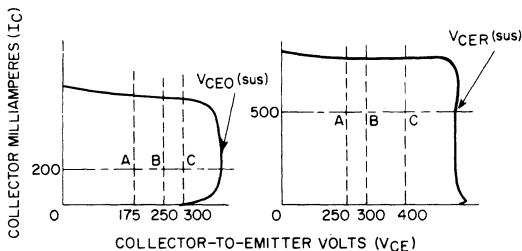
92CS-12586

Note 1: R₁ = 110 ohms, 1w for V_{CE0(sus)}
= 39 ohms, 1w for V_{CER(sus)}

Note 2: L₁ = 20 mh for V_{CE0(sus)}
= 500 μh for V_{CER(sus)}



OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGES

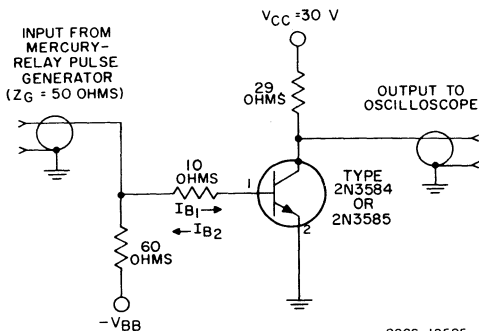


92CS-12875

Note: The sustaining voltages $V_{CE(sus)}$ and $V_{CE(sus)}$ are acceptable when the traces fall to the right and above points "A", "B", and "C" for types 2N3583, 2N3584, and 2N3585, respectively.

CIRCUIT USED TO MEASURE SWITCHING TIMES

2N3584 & 2N3585



92CS-12585

Input Pulse:

$t_r < 3 \text{ nsec}$

$t_f < 10 \text{ nsec}$

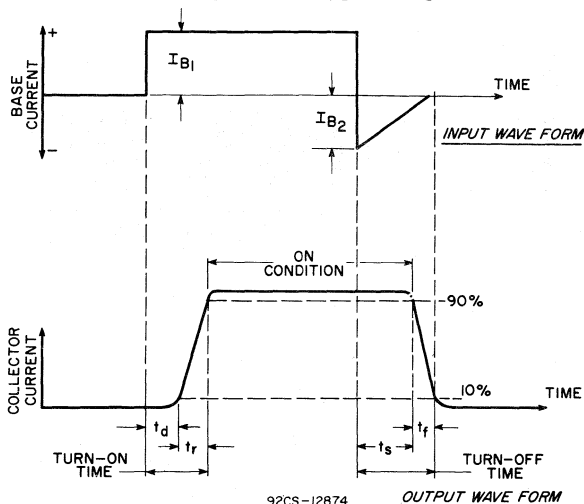
Rep. Rate = 5 kc

Pulse Width = 20 μsec



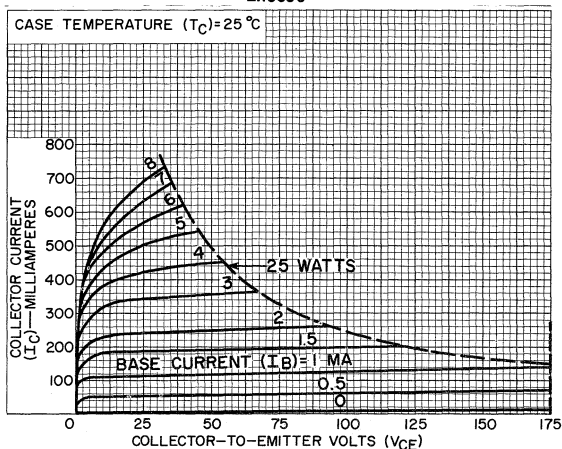
2N3583, 2N3584, 2N3585

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SWITCHING TIMES



Typical Output Characteristics

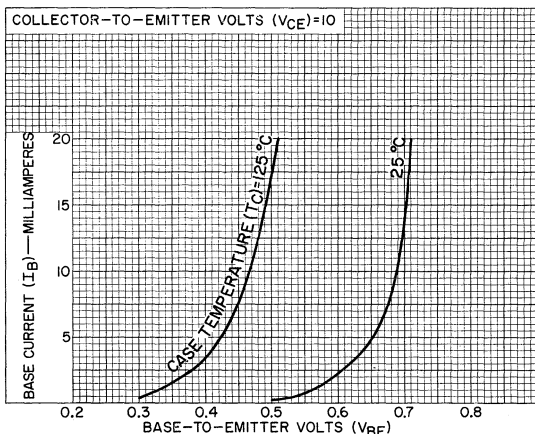
2N3583



2N3583, 2N3584, 2N3585

Typical Input Characteristics

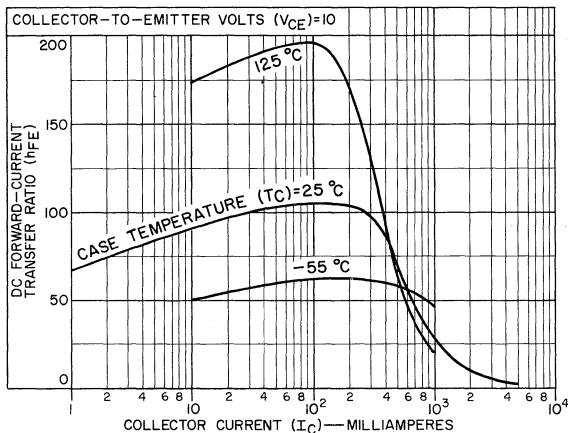
2N3583, 2N3584, & 2N3585



92CS-12881

Typical DC Forward-Current Transfer-Ratio Characteristics

2N3583



92CS-12884

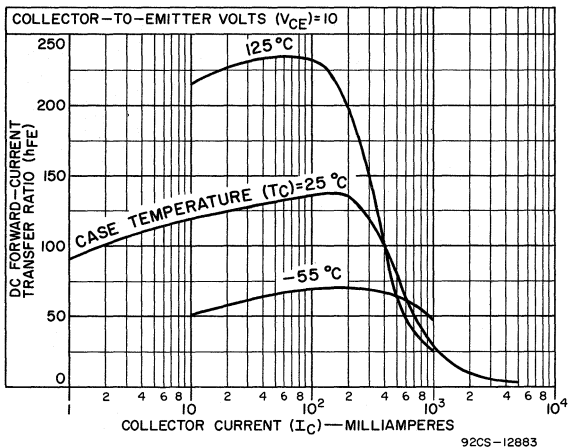


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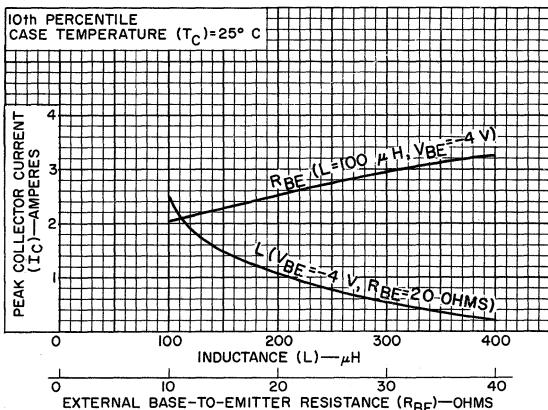
DATA 4
2-65

2N3583, 2N3584, 2N3585

Typical DC Forward-Current Transfer-Ratio Characteristics 2N3584 & 2N3585

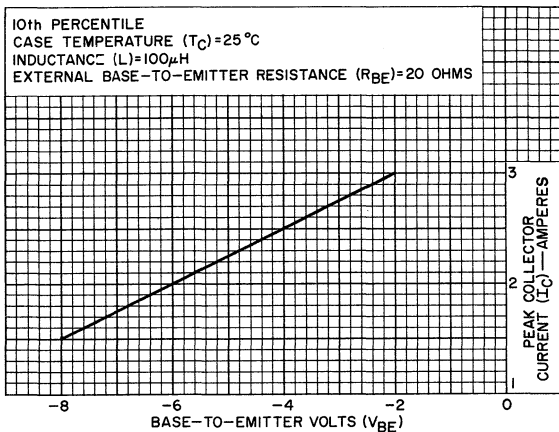


Reverse-Bias Second-Breakdown Characteristics 2N3583, 2N3584, & 2N3585



Reverse-Bias Second-Breakdown Characteristics

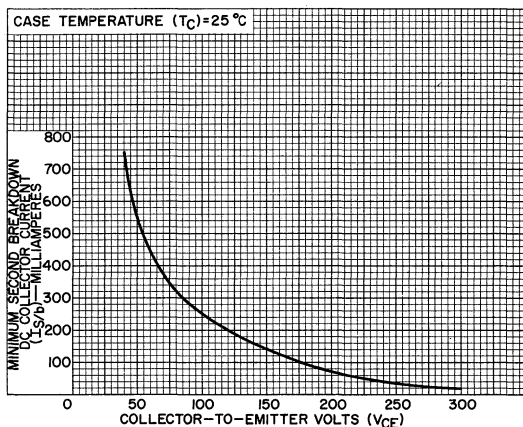
2N3583, 2N3584, & 2N3585



92CS-12877

Forward-Bias Second-Breakdown Characteristic

2N3583, 2N3584, & 2N3585



92CS-12876



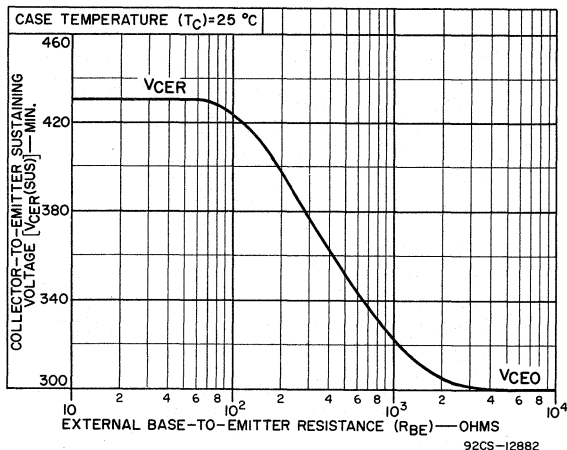
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DATA 5
2-65

2N3583, 2N3584, 2N3585

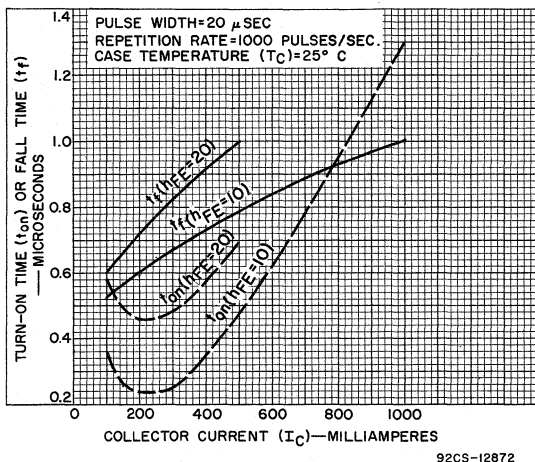
Sustaining Voltage vs. Base-To-Emitter Resistance

2N3584 & 2N3585



Turn-On Time & Fall Time vs. Collector Current

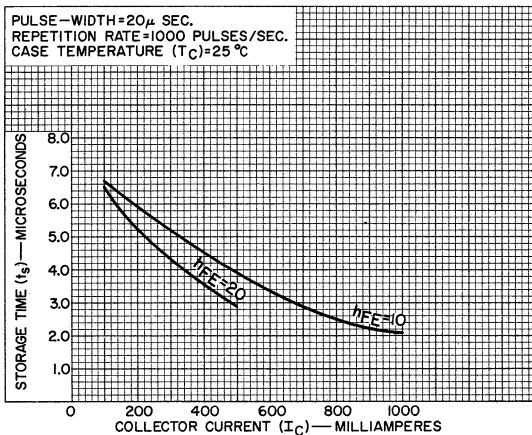
2N3584 & 2N3585



2N3583, 2N3584, 2N3585

Storage Time vs. Collector Current

2N3584, & 2N3585



92CS-12880



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DATA 6
2-65

Transistor

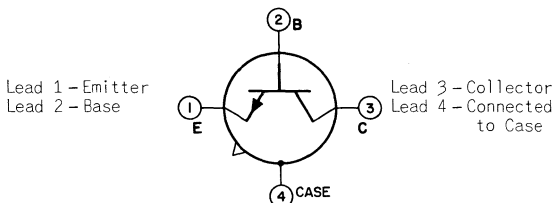
SILICON N-P-N EPITAXIAL-PLANAR TYPE

4-LEAD TO-18 TYPE CASE

*For Low-Noise Amplifier, Oscillator, & Converter
Applications at VHF Frequencies in Military,
Communications, & Industrial Equipment*

Dimensions. See accompanying *Dimensional Outline*

Terminal Diagram: **BOTTOM VIEW**



MAXIMUM RATINGS, Absolute-Maximum Values

Collector-to-Base Voltage	V_{CB0}	30	volts
Collector-to-Emitter Voltage.	V_{CE0}	15	volts
Emitter-to-Base Voltage	V_{EB0}	3	volts
Collector Current ^a	I_C	-	

Transistor Dissipation

At case temperatures with heat sink:^b

From -65° to 25° C.	P_T	300	mw
Above 25° C.	Derate linearly	1.71	mw/°C

At free-air temperatures:

From -65° to 25° C.	P_T	200	mw
Above 25° C.	Derate linearly	1.71	mw/°C

Temperature Range

Operating (Junction).	T_{opr}	-65 to 200	°C
Storage	T_{stg}	-65 to 200	°C

Lead-Soldering Temperature ^c	T_L	255	°C
---	-------	-----	----

(For 60 sec. max.)

ELECTRICAL CHARACTERISTICS

*Unless otherwise specified, electrode voltage
and electrode-current values for given test
conditions are dc at case temperature = 25° C*

Min. Typ. Max.

Collector-to-Base

Breakdown Voltage.	BV_{CB0}	30	-	-	volts
----------------------------	------------	----	---	---	-------

$I_C = 0.001$ ma, $I_E = 0$



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DATA 1
4-65

Min. Typ. Max.

Emitter-to-Base

Breakdown Voltage BV_{EBO} 3 - - volts
 $I_E = 0.01$ ma, $I_C = 0$

Collector-to-Emitter

Sustaining Voltage $BV_{CEO}(sus)$ 15 - - volts
 $I_C = 3$ ma, $I_B = 0$

Base-to-Emitter

Saturation Voltage $V_{BE}(sat)$ - - 1 volt
 $I_C = 10$ ma, $I_B = 1$ ma

Collector-to-Emitter

Saturation Voltage $V_{CE}(sat)$ - - 0.4 volt
 $I_C = 10$ ma, $I_B = 1$ ma

Collector Cutoff Current

$V_{CB} = 15$ volts, $I_E = 0$,
 $T_{FA} = 25^\circ C$ I_{CBO} - - 0.01 μa
 $T_{FA} = 150^\circ C$ I_{CBO} - - 1 μa

DC Forward-Current

Transfer Ratio h_{FE} 20 - 150
 $V_{CE} = 1$ volt, $I_C = 3$ ma

Small-Signal Forward-Current Transfer Ratio^d

$V_{CE} = 6$ volts,
 $f = 1$ kc, $I_C = 2$ ma. h_{fe} 40 - 200
 $f = 100$ Mc, $I_C = 5$ ma. h_{fe} 8.5 - 15

Input Capacitance^e C_{ib} - 1.4 - pf

$f = 0.1$ to 1 Mc
 $V_{EB} = 0.5$ volt, $I_C = 0$

Output Capacitance^e C_{ob} - - 1.7 pf

$f = 0.1$ to 1 Mc,
 $V_{CB} = 10$ volts, $I_E = 0$

Collector-to-Base

Time Constant^d $r_b' C_c$ 4 - 15 psec
 $f = 31.9$ Mc, $I_C = 5$ ma,
 $V_{CB} = 6$ volts

Small-Signal Power Gain G_{pe} 17 - 24 db

NEUTRALIZED AMPLIFIER
CIRCUIT^{d, f} — $f = 200$ Mc,
 $V_{CE} = 6$ volts, $I_C = 5$ ma

Power Output P_o 20 - - mw

OSCILLATOR CIRCUIT^{e, g} —
 $f = 500$ Mc, $I_E = 12$ ma,
 $V_{CB} = 10$ volts

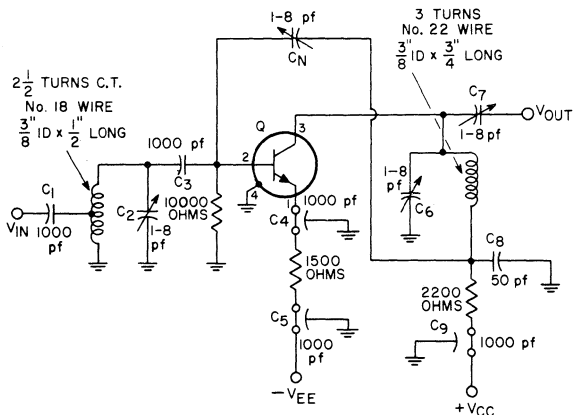
Noise Figure^d

$V_{CE} = 6$ volts,
 $f = 200$ Mc, $I_C = 1.5$ ma. NF^f - - 4.5 db
 $f = 60$ Mc, $I_C = 1$ ma,
 $R_G^h = 400$ ohms. NF - 3 - db



- a Limited by transistor dissipation.
 b Measured at center of seating surface.
 c Measured along lead at distance not less than $1/32"$ from seating plane.
 d Lead 4 (case) grounded.
 e Lead 4 (case) floating.
 f See accompanying *Neutralized Amplifier Circuit*.
 g See accompanying *Oscillator Circuit*.
 h R_G = Generator resistance.

POWER GAIN & NOISE FIGURE TEST CIRCUIT
 Neutralized Amplifier, 200-Mc



92CS-11930

Note: (Neutralization Procedure): (a) Connect a 200-Mc signal generator (with $Z_{out} = 50$ ohms) to the input terminals of the amplifier. (b) Connect a 50-ohm rf voltmeter across the output terminals of the amplifier. (c) Apply VEE and VCC, and with the signal generator adjusted for 10 mv output, tune C_2 , C_6 , and C_7 for maximum output. (d) Interchange the connections to the signal generator and the output indicator. (e) With sufficient signal applied to the output terminals of the amplifier, adjust C_N for a minimum indication at the input. (f) Repeat steps (a), (b), and (c) to determine if retuning is necessary.

Q = Type 2N3600

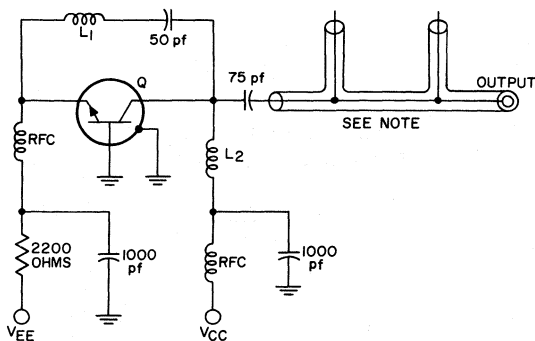


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DATA 2
 4-65

POWER OUTPUT TEST CIRCUIT

Oscillator, 500-Mc



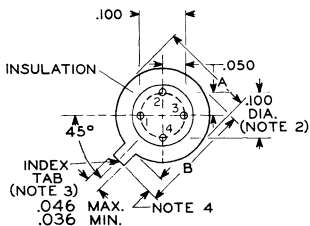
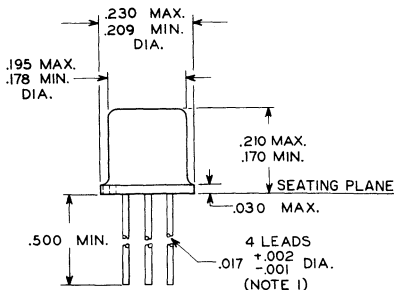
92CS-12849R1

Note: Coaxial-Line output network consisting of:

- 2 General Radio Type 874 TEE or equivalent
- 1 General Radio Type 874-D20 Adjustable Stub or equivalent
- 1 General Radio Type 874-LA Adjustable Line or equivalent
- 1 General Radio Type 874-WN3 Short-circuit termination or equivalent
- L_1 = 9 turns #16AWG wire, 3/8 inch OD, 1-1/4 inch long or equivalent
- L_2 = 2 turns #16AWG wire, 3/8 inch OD, 1-1/4 inch long or equivalent
- Q = 2N3600



DIMENSIONAL OUTLINE



92CS-12817

DIMENSIONS IN INCHES

Note 1: The specified lead diameter applies in the zone between 0.050" and 0.250" from the seating plane. From 0.250" to the end of the lead a maximum diameter of 0.021" is held. Outside of these zones, the lead diameter is not controlled.

Note 2: Maximum diameter leads at a gauging plane 0.054" + 0.001" - 0.000" below seating plane to be within 0.007" of their true location relative to max. width tab and to the maximum 0.230" diameter measured with a suitable gauge. When gauge is not used, measurement will be made at seating plane.

Note 3: For visual orientation only.

Note 4: Tab length to be 0.028" minimum - 0.048" maximum, and will be determined by subtracting diameter A from dimension B.

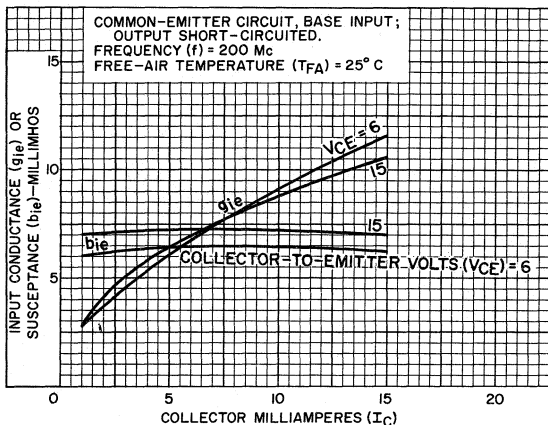
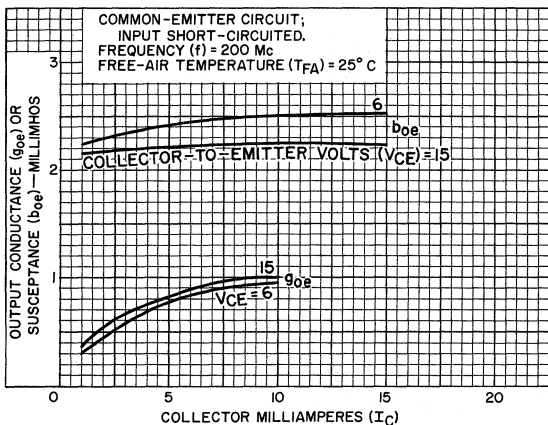


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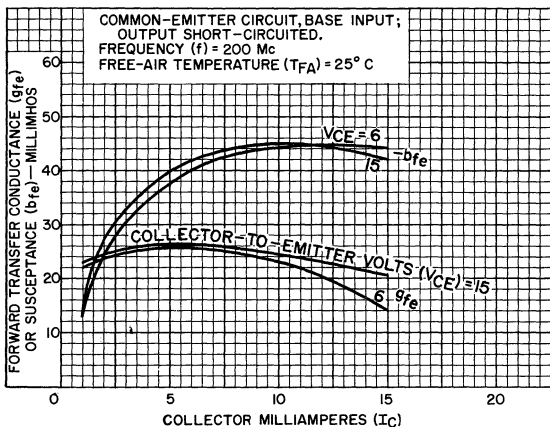
Harrison, N. J.

DATA 3
4-65

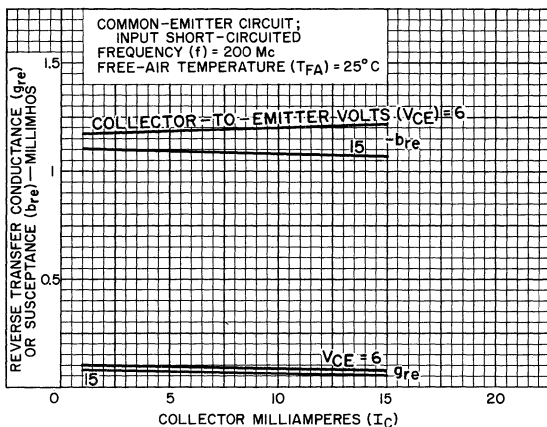
Two-Port Admittance "Y" Parameters

INPUT ADMITTANCE (y_{ie})OUTPUT ADMITTANCE (y_{oe})

Two-Port Admittance "Y" Parameters

FORWARD TRANSADMITTANCE (y_{fe})

92CS-12759

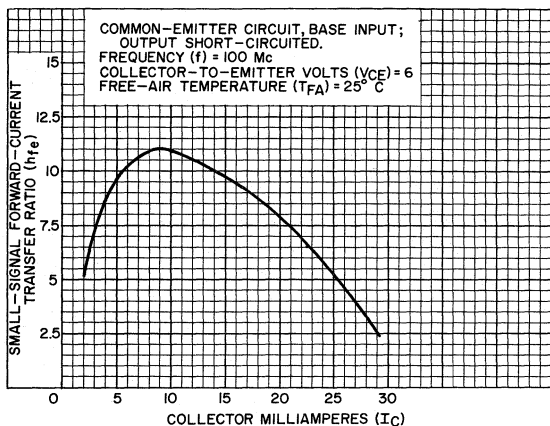
REVERSE TRANSADMITTANCE (y_{re})

92CS-12760



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DATA 4
4-65

Typical Small-Signal Beta (h_{fe}) Characteristic

92CS-12845



Transistor

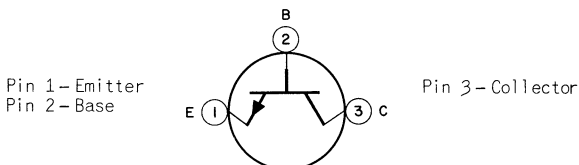
SILICON N-P-N "OVERLAY" EPITAXIAL-PLANAR TYPE

For Large-Signal, High-Power VHF Applications in Industrial and Military Communications Equipment Under Class-A, -B, or -C Amplifier, or Frequency Multiplier Operation

Mechanical:

Dimensions. See Outline TO-60 in General Section

Terminal Diagram: BOTTOM VIEW



All electrodes are electrically isolated from case

RADIO-FREQUENCY SERVICE

Maximum Ratings, Absolute-Maximum Values:

Collector-to-Base Voltage.	V_{CBO}	65	volts
Collector-to-Emitter Voltage			
With $V_{BE} = -1.5$ volts.	V_{CEV}	65	volts
With base open	V_{CEO}	40	volts
Emitter-to-Base Voltage.	V_{EBO}	4	volts
Collector Current.	I_C	3	amp

Transistor Dissipation

At case temperatures:

From -65° to 25°C	P_T	23	watts
Above 25°C	Derate linearly 0.131 watt/ $^{\circ}\text{C}$		

Temperature Range

Operating (Junction)	T_{opr}	-65 to 200	$^{\circ}\text{C}$
Storage.	T_{stg}	-65 to 200	$^{\circ}\text{C}$

Pin-Soldering Temperature ^a	T_p	230	$^{\circ}\text{C}$
(For 10 sec. max.)			

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode-voltage and electrode-current values for given test conditions are dc; case temperature = 25°C .

Min. Typ. Max.

Collector-to-Base Breakdown

Voltage.	BV_{CBO}	65	-	-	volts
$I_C = 0.5$ ma, $I_E = 0$					



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DATA 1
2-65

		Min.	Typ.	Max.	
Collector-to-Emitter Breakdown Voltage					
I_C (Pulsed) = 0 to 200 ma, ^b					
$V_{EB} = -1.5$ volts.	BV_{CEV}	65 ^c	-	-	volts
I_C (Pulsed) = 0 to 200 ma, ^b					
$I_B = 0$	BV_{CEO}	40 ^c	-	-	volts
Emitter-to-Base Breakdown Voltage					
$I_E = 0.25$ ma, $I_C = 0$	BV_{EBO}	4	-	-	volts
Collector-to-Emitter Saturation Voltage					
$I_C = 0.5$ ampere, $I_B = 100$ ma	$V_{CE}(sat)$	-	-	1	volt
Collector-Cutoff Current					
$V_{CE} = 30$ volts, $I_B = 0$	I_{CEO}	-	-	0.25	ma
Base-Spreading Resistance					
$f = 200$ Mc., $V_{CE} = 28$ volts, $I_C = 250$ ma	r_{bb} ¹	-	6.5	-	ohms
Output Capacitance					
$f = 1$ Mc, $V_{CR} = 30$ volts, $I_E = 0$	C_{ob}	-	-	20	pf
Collector-to-Case Capacitance					
	C_c	-	-	6	pf
Gain-Bandwidth Product					
$V_{CE} = 28$ volts, $I_C = 150$ ma	f_T	-	400	-	Mc
RF Power Output Amplifier, Unneutralized^d					
$f = 175$ Mc, $V_{CC} = 28$ volts, $P_i = 3.5$ watts.	P_o	13.5 ^e	-	-	watts
$f = 260$ Mc, $V_{CC} = 28$ volts, $P_i = 3$ watts.	P_o	-	10 ^f	-	watts

^a Measured along pin at distances not less than 1/32" from ceramic wafer.

^b Pulsed through an inductor (25mh); duty factor = .5.

^c Measured at a current where the breakdown voltage is a minimum.

^d See accompanying *Power-Output-Measurement Circuits*.

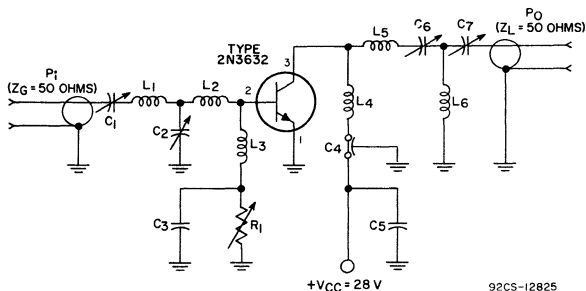
^e For conditions given, minimum efficiency = 70 per cent.

^f For conditions given, minimum efficiency = 60 per cent.



POWER-OUTPUT MEASUREMENT CIRCUIT

Unneutralized RF Amplifier, 175- & 260-Mc



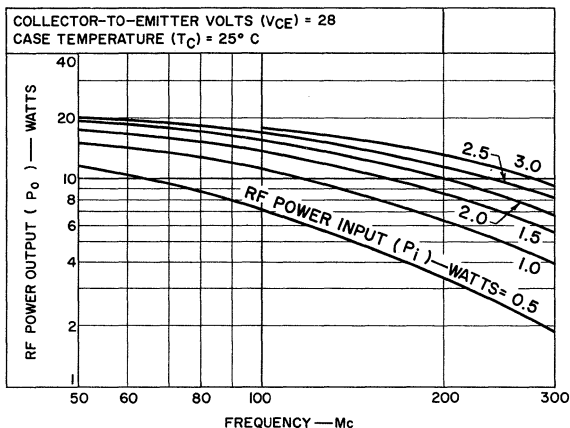
For 175-Mc Operation:

- C1, C6: 3-35 pf
- C2, C7: 8-60 pf
- C4: 1,000 pf
- C3, C5: 0.005 μ f, disc ceramic
- L1, L5: 4 turns No. 18 wire, 1/4" ID, 3/16" long
- L2: 1 turn No. 16 wire, 1/4" ID, 3/16" long
- L3: Ferrite choke, Z = 450 ohms
- L4: RF choke, 1.0 μ h
- L6: 2-1/2 turns No. 16 wire, 1/4" ID, 1/4" long
- R1: 50 ohms

For 260-Mc Operation:

- C1: 3-35 pf
- C2, C7: 8-60 pf
- C3, C5: 0.005 μ f, disc ceramic
- C4: 1,000 pf
- C6: 1.5-20 pf
- L1: 3 turns No. 18 wire, 1/4" ID, 1/4" long
- L2: 3/16" wide copper strip, 3/8" long
- L3: Ferrite choke, Z = 450 ohms
- L4: RF choke, 0.47 μ h
- L5: 3-1/2 turns No. 16 wire, 1/4" ID, 7/16" long
- L6: 1 turn No. 16 wire, 1/4" ID, 3/8" long
- R1: 50 ohms

Typical Operation Characteristics



92CS-13078

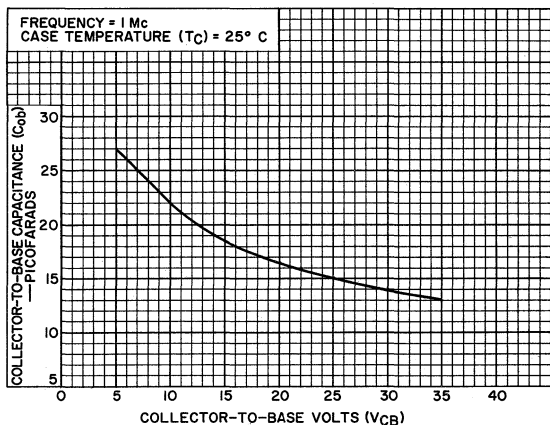
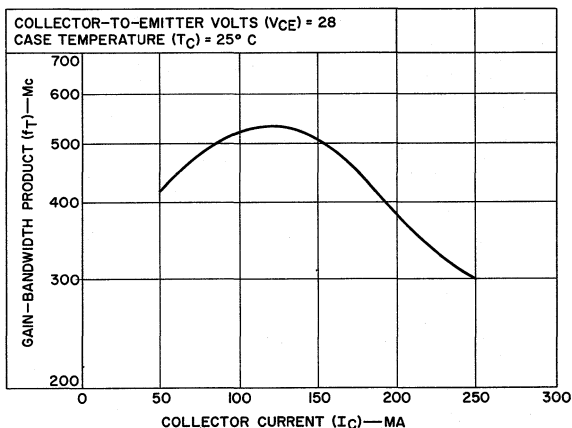


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Electronic Components and Devices

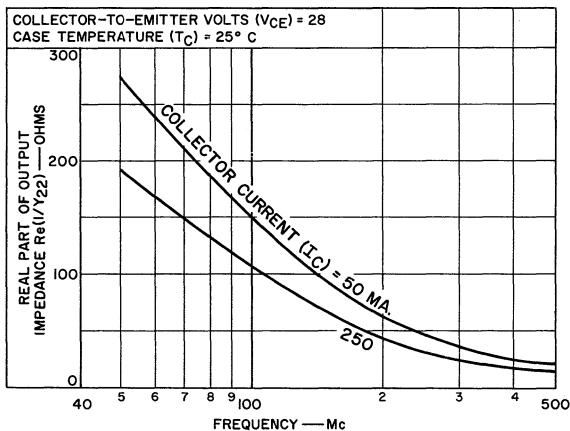
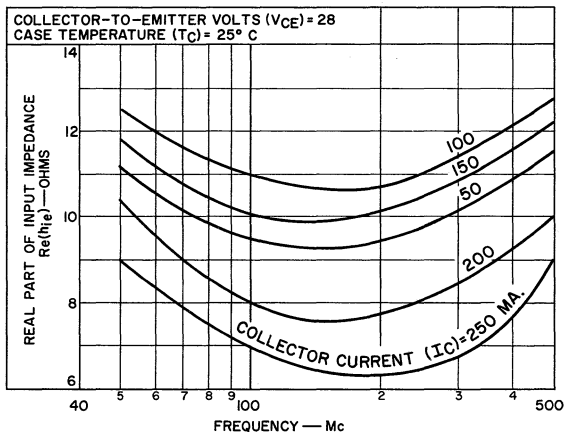
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DATA 2
2-65

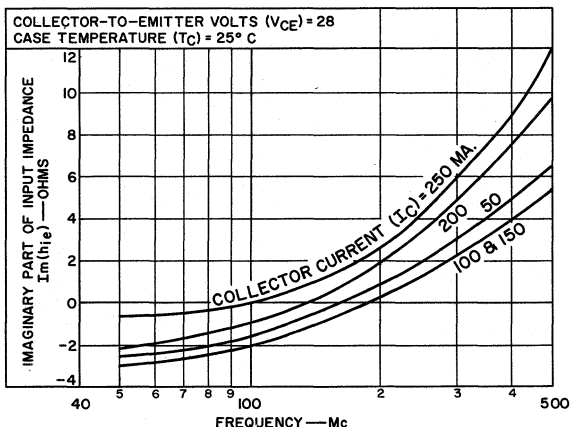
Typical Small-Signal Operation Characteristics



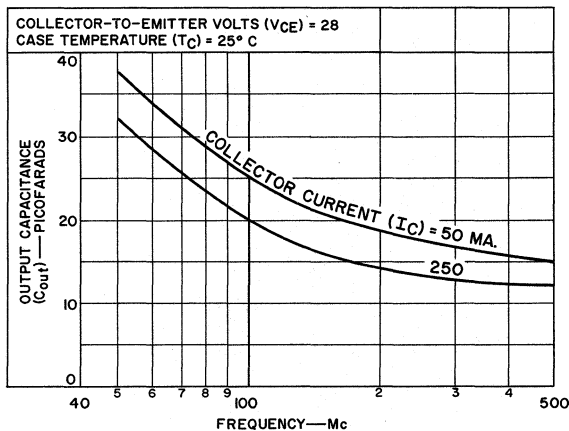
Typical Small-Signal Operation Characteristics



Typical Small-Signal Operation Characteristics



92CS-12841



92CS-12832

2N3668, 2N3669, 2N3670

Silicon Controlled Rectifiers (Thyristors)

ALL-DIFFUSED, 3-JUNCTION TYPE

*For Low-Cost Power-Control
an Power-Switching Applications*

2N3668-For Low-Voltage Power Supplies

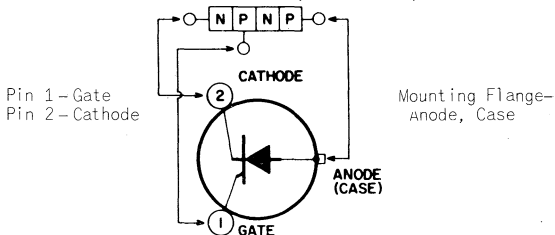
2N3669-For 120-Volt Line Operation

2N3670-For 240-Volt Line Operation

MECHANICAL

Dimensions See Outline TO-3 in General Section

TERMINAL DIAGRAM (Bottom View)



The arrow indicates direction of forward current

ABSOLUTE-MAXIMUM RATINGS^a

*Unless otherwise specified, for sinusoidal ac supply
voltage at a frequency between 50 and 400 Hz, with
resistive or inductive load*

		2N3668	2N3669	2N3670	
Peak Reverse Voltage					
Gate open:					
Repetitive	$V_{RM}(rep)$	100	200	400	V
Non-repetitive (Transient) for duration of 5 ms . . .	$V_{RM}(non-rep)$	150	330	660	V
Peak Forward Blocking Voltage					
Repetitive, gate open . . .	$V_{FBOM}(rep)$	600	600	600	V
Average Forward Current					
T_C with heat sink from -65 to 80 °C:					
DC value at a conduction angle of 180°	I_{FAV}	8	8	8	A
RMS value	I_{FRMS}	12.5	12.5	12.5	A
For other conditions, see Rating Chart (Case Temperature)					



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DATA 1
4-66

2N3668, 2N3669, 2N3670

		2N3668	2N3669	2N3670	
Peak Surge Current					
1 Cycle of applied voltage. . .	$i_{FM}(\text{surge})$	200	200	200	A
More than 1 cycle of applied voltage.	$i_{FM}(\text{surge})$	See Peak-Surge Current Rating Chart			
→ Sub-Cycle Surge^b	I^2t	165	165	165	A ² s
Non-repetitive, for a period of 1 ms to 8.3 ns					
→ Rate of Change of Forward Current	di/dt	200	200	200	A/ μ s
$V_{FB} = v_{B00}(\text{min value})$					
$I_{GT} = 200 \text{ mA}$, 0.5 μ s rise time					
→ Gate Power^c					
Peak, forward or reverse, for 10 μ s duration	P_{GM}	40	40	40	W
Average	P_{GAV}	0.5	0.5	0.5	W
Temperature Range^d					
Operating (Case)	T_{opr}	-40 to 100			°C
Storage	T_{stg}	-40 to 125			°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, at maximum electrical ratings and at indicated case temperatures

		2N3668	2N3669	2N3670	
Forward Breakover Voltage	V_{B00}	100	200	400	min V
$T_C = 100^\circ\text{C}$					
Instantaneous Forward Voltage Drop	V_F	{ 1.4 1.8	{ 1.4 1.8	{ 1.4 1.8	{ typ V max V
$T_C = 25^\circ\text{C}$, $i_F = 25 \text{ A}$					
DC Gate-Trigger Voltage	V_{GT}	{ 1.5 2	{ 1.5 2	{ 1.5 2	{ typ V max V
Anode to cathode volts = 6, $T_C = 25^\circ\text{C}$					
Peak Blocking Current					
$T_C = 100^\circ\text{C}$:					
Forward, $V_{FBO}^e = v_{B00}(\text{min value})$	i_{FBO}	{ 0.2 2	{ 0.25 2.5	{ 0.3 3	{ typ mA max mA
Reverse, $V_{RBO}^f = v_{FM}(\text{rep value})$	i_{RBO}	{ 0.05 1	{ 0.1 1.25	{ 0.2 1.5	{ typ mA max mA
DC Gate-Trigger Current	I_{GT}	{ 20 40	{ 20 40	{ 20 40	{ typ mA max mA
Anode to cathode volts = 6, $T_C = 25^\circ\text{C}$					
Holding Current	i_{H00}	{ 0.5 25 50	{ 0.5 25 50	{ 0.5 25 50	{ min mA typ mA max mA
$T_C = 25^\circ\text{C}$, with gate open					
Critical Rate of Applied Forward Voltage	Critical dv/dt	{ 10 100	{ 10 100	{ 10 100	{ min/ μ s typ/ μ s
$V_{FB} = v_{B00}(\text{min value})$, exponential rise, $T_C = 100^\circ\text{C}$					
Turn-On Time	t_{on}	{ 0.75 1.25	{ 0.75 1.25	{ 0.75 1.25	{ min/ μ s typ/ μ s
$V_{FB} = v_{B00}(\text{min value})$, $i_F = 8 \text{ A}$, $I_{GT} = 200 \text{ mA}$, 0.1 μ s rise time, $T_C = 25^\circ\text{C}$					

→ Indicates a change.



2N3668, 2N3669, 2N3670

		2N3668	2N3669	2N3670		
Turn-Off Time	t_{off}	$\begin{cases} 20 \\ 50 \end{cases}$	$\begin{cases} 20 \\ 50 \end{cases}$	$\begin{cases} 20 \\ 50 \end{cases}$	typ max	μs μs
$i_F = 8 \text{ A}$, $50 \mu s$ pulse width, $dv_{FB}/dt = 20 \text{ V}/\mu s$, $di_F/dt = 30 \text{ A}/\mu s$, $I_{GT} = 200 \text{ mA}$, $T_C = 80^\circ C$						
Thermal Resistance	θ_{JC}	1.7	1.7	1.7	max	$^\circ C/W$
Junction-to-Case						

- a Terms, Symbols, and Definitions for the data given are shown in the General Section of the Handbook.
- b The non-recurrent surge capability of the device for sub-cycle pulses where I is RMS amperes and t is pulse duration in seconds.
- c Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.
- d Temperature reference point is within 1/8 inch of the center of the underside of unit.
- e V_{FBO} = DC forward blocking voltage with gate open.
- f V_{RBO} = DC reverse blocking voltage with gate open.

TRIGGERING CONSIDERATIONS

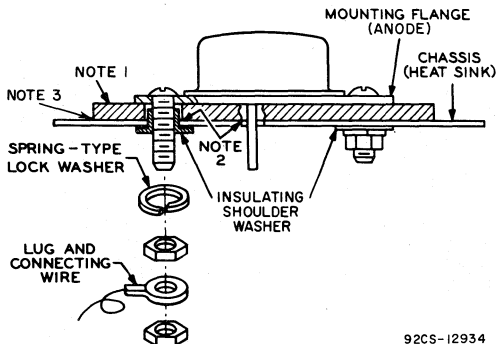
The construction of the gate-cathode-junction used in these devices provides a large periphery center gate. These devices also employ integral-resistance constructions which removes restrictions on both forward and reverse peak gate voltage and peak gate current. Limiting values of volt-ampere products for different gate pulse widths are shown under *Forward Gate Characteristics*. These limits should be adhered to when designing pulse trigger circuits for maximum trigger pulse widths and peak power dissipation. The volt-ampere products in the reverse direction shown under *Reverse Gate Characteristics* should be used to determine limitations for reverse gate transients or reverse gate pulses if present. In all cases, total average gate dissipation, both forward and reverse, should not exceed the average gate dissipation rating (P_{GAV}) of 0.5 watt.

Turn-on times different gate currents are shown under *Turn-On Time Characteristics*. These curves may be used to determine the required width of the gate trigger pulses. It is only necessary to maintain the gate trigger until the magnitude of the forward anode current has reached the latching current value. However, conservative design requires that the gate trigger pulse width be at least equal to or somewhat greater than the device turn-on time. Some applications may require wider gate pulse widths for proper circuit operation. Additional information on gate characteristics and triggering requirements for use in pulse applications are contained in RCA Application Note, SMA-39, "Gate Parameters of RCA SCR's for Trigger Circuit Design".



2N3668, 2N3669, 2N3670

SUGGESTED INSULATED MOUNTING ARRANGEMENT

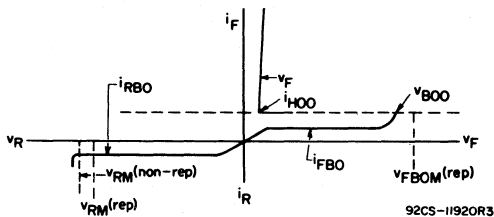


Note 1: 0.002 inch mica insulator or anodized aluminum insulator (drilled or punched with burrs removed).

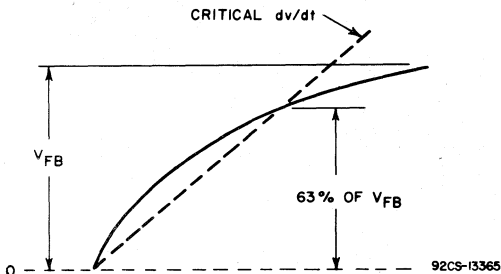
Note 2: Remove burrs from chassis holes.

Note 3: Dow corning 340 silicon heat sink compound, or equivalent.

TYPICAL E-I CHARACTERISTIC OF SILICON CONTROLLED RECTIFIER

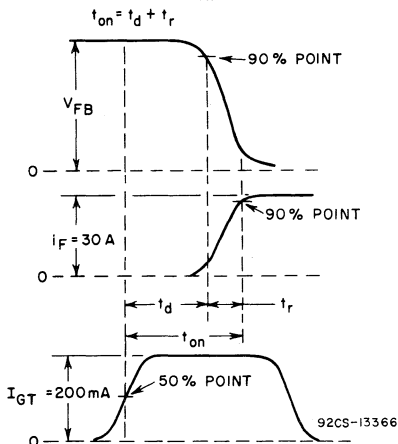


WAVESHAPE OF CRITICAL dv/dt RATING TEST

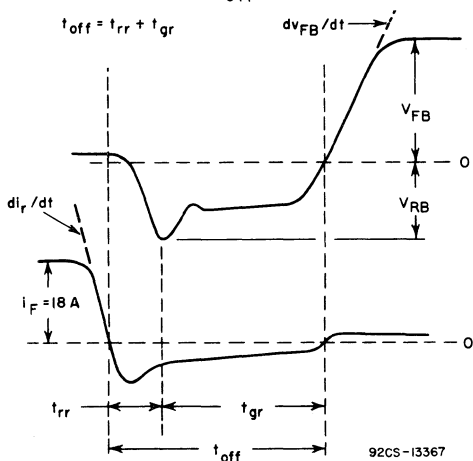


2N3668, 2N3669, 2N3670

WAVESHAPE OF t_{on} RATING TEST



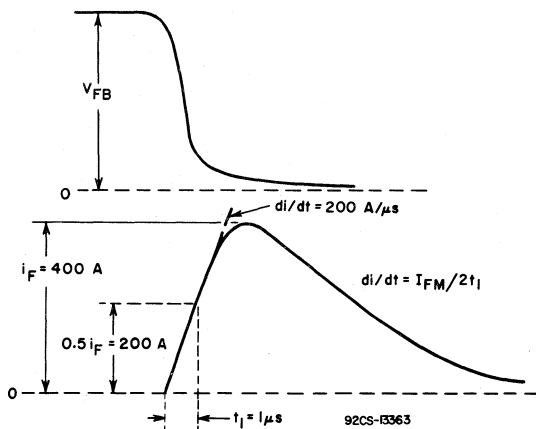
WAVESHAPE OF t_{off} RATING TEST



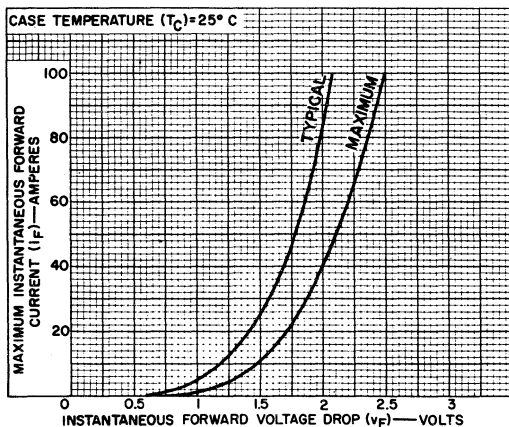
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DATA 3
4-66

2N3668, 2N3669, 2N3670



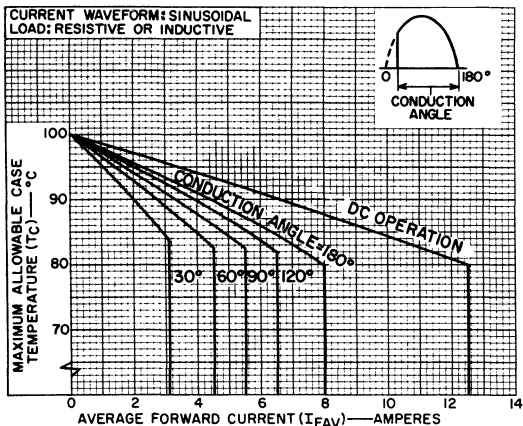
Forward Characteristics



92CS-12931



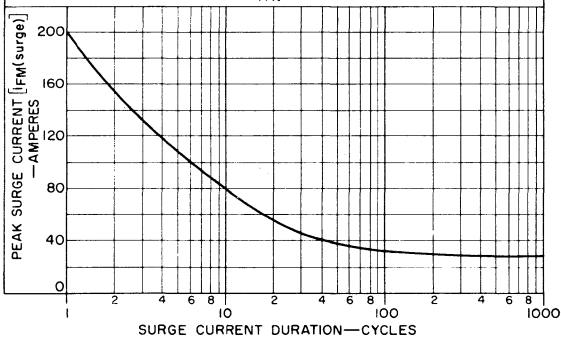
Rating Chart (Case Temperature)



92CS-12922

Peak Surge Current Rating Chart

SUPPLY FREQUENCY = 60 Hz SINE WAVE
CASE TEMPERATURE = 80° C
LOAD = RESISTIVE
REPETITIVE PEAK REVERSE VOLTAGE [$V_{RM(rep)}$] = MAXIMUM-RATED VALUE
AVERAGE FORWARD CURRENT (I_{FAV}) = MAXIMUM-RATED VALUE



92CS-12932RI



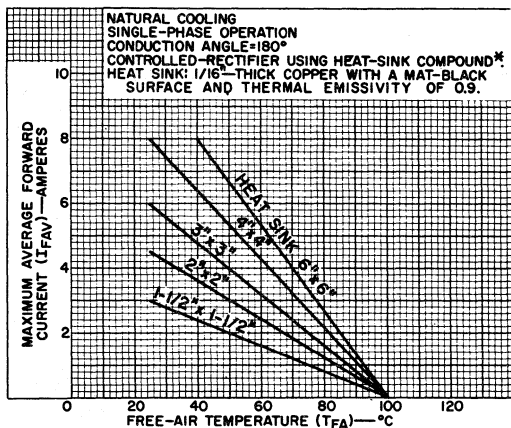
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DATA 4
4-66

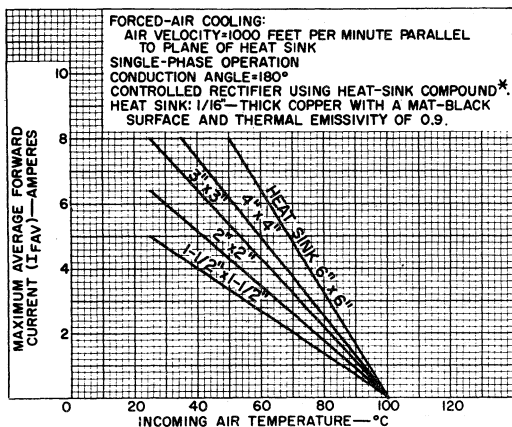
2N3668, 2N3669, 2N3670

Natural-Air Cooling Operation Guidance Chart



92CS-12930

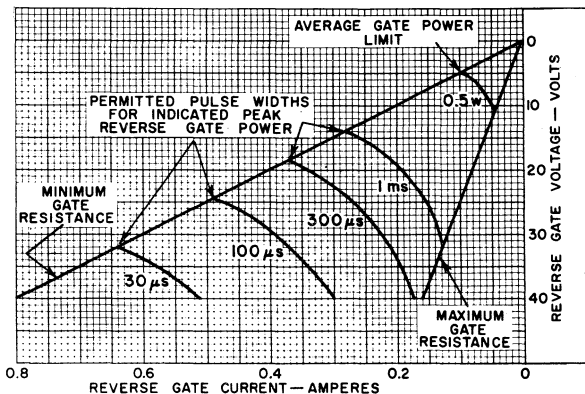
Forced-Air Cooling Operation Guidance Chart



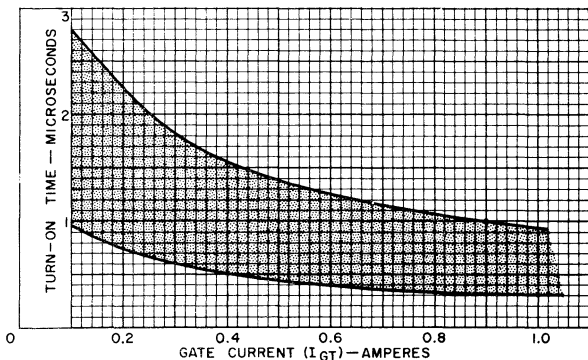
92CS-12933



Reverse Gate Characteristics

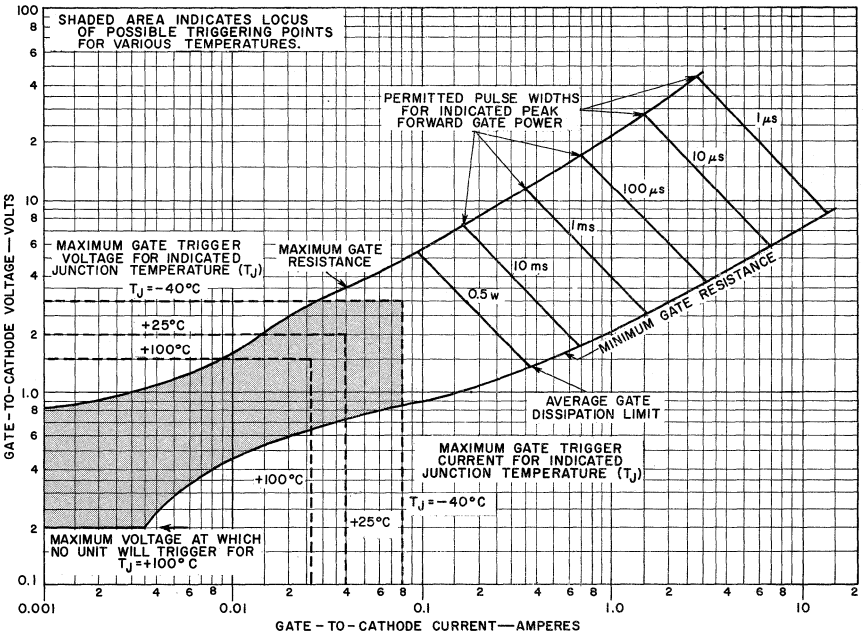


Turn-on Time Characteristics



2N3668, 2N3669, 2N3670

Forward Gate Characteristics

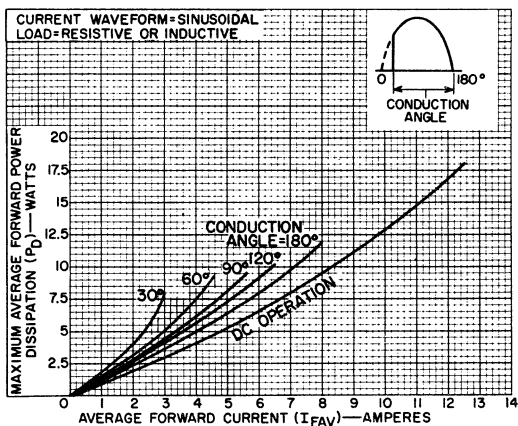


DATA 5

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Power Dissipation Chart

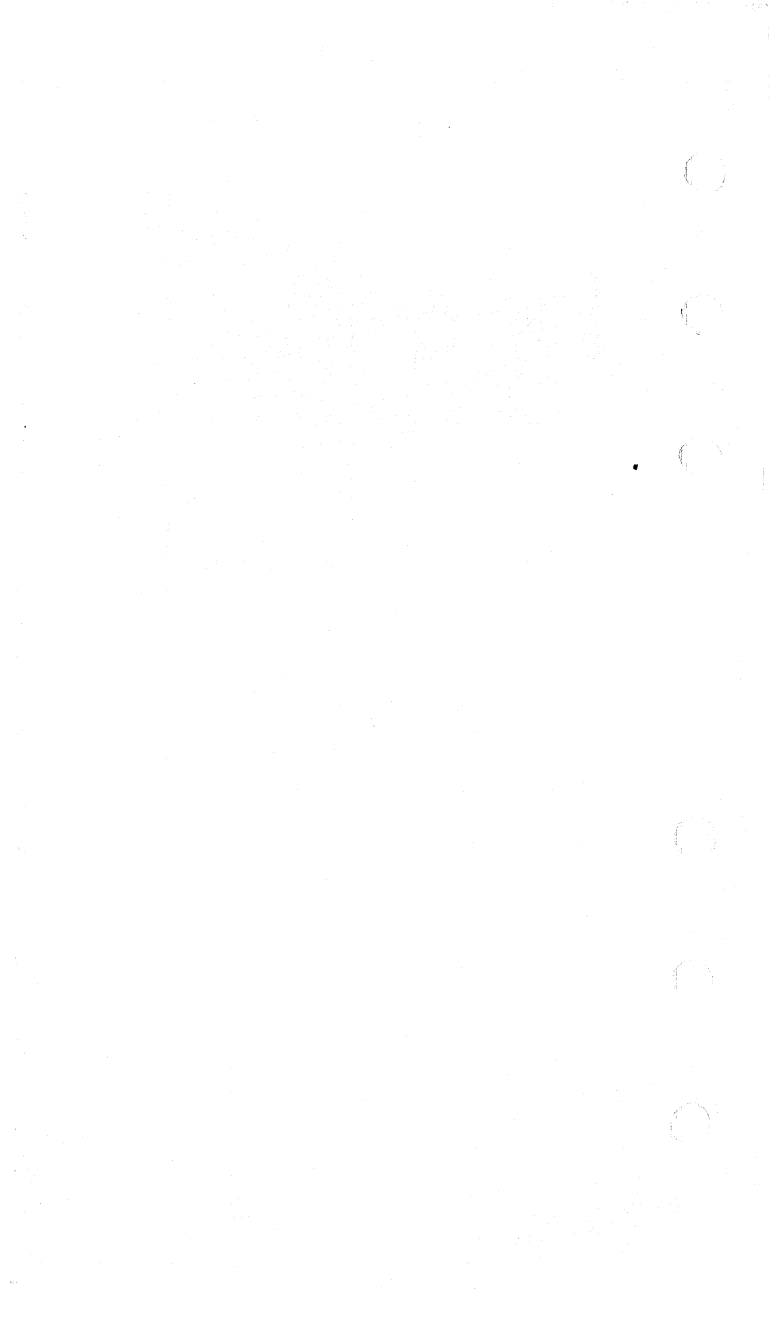


92CS-12935



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DATA 6
4-66



2N3730, 2N3731, 2N3732

Power Transistors

GERMANIUM P-N-P DIFFUSED-COLLECTOR GRADED-BASE TYPES

For Use in 114-Degree, 18-kV TV Deflection Systems

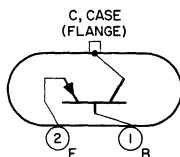
2N3730 — Intended for Use as a Vertical Deflection Output Amplifier

2N3731 and **2N3732** — Intended for Use Respectively as a Horizontal Output Amplifier and Horizontal Driver as part of a Transistor/Damper-Diode Complement with Type **1N4785**

Dimensions. See Outline TO-3 in General Section
Terminal Diagram

BOTTOM VIEW

Pin 1—Base
Pin 2—Emitter



Mounting Flange—
Collector, Case

TELEVISION DEFLECTION SERVICE

Absolute-Maximum Ratings

2N3730 2N3731 2N3732

Collector-to-Base Voltage

Peak.	V_{CB0}	-200	-320	-100	V
Continuous.	V_{CB}	-60	-60	-60	V

Emitter-to-Base Voltage	V_{EB0}	-0.5	-2	-0.5	V
-----------------------------------	-----------	------	----	------	---

Collector Current	I_C	-3	-10	-3	A
-----------------------------	-------	----	-----	----	---

Base Current.	I_B	± 0.5	+4, -1	± 0.5	A
-----------------------	-------	-----------	--------	-----------	---

Transistor Dissipation

At mounting-flange
temperatures:^a

Up to 55° C	P_T	10	5	3	W
-----------------------	-------	----	---	---	---

Above 55° C	Derate linearly to 0 W at 85° C				
-----------------------	---------------------------------	--	--	--	--

Temperature Range

Operating (Junction).	$T(opr)$	-65 to 85	°C
-------------------------------	----------	-----------	----

Storage	$T(stg)$	-65 to 85	°C
-------------------	----------	-----------	----

Pin-Soldering Temperature		230	230	230	°C
-------------------------------------	--	-----	-----	-----	----

For 10 sec. max^b



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DATA 1
9-65

2N3730, 2N3731, 2N3732

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode voltage and electrode-current values for given test conditions are dc at free-air temperature = 25° C

2N3730 2N3731 2N3732

Collector-to-Base

Breakdown Voltage

$V_{EB} = -0.5 \text{ V},$ $I_C = -0.025 \text{ A} \dots$	BVCBV	-	-320	-	min	V
$V_{EB} = -0.5 \text{ V},$ $I_C = -0.005 \text{ A} \dots$	BVCBV	-200	-	-100	min	V

Emitter-to-Base

Breakdown Voltage. . . BVEBO

$I_C = 0, I_E = -100 \text{ mA}$		-	-2	-	min	V
----------------------------------	--	---	----	---	-----	---

Collector-to-Emitter

Saturation Voltage

$I_C = -6 \text{ A}, I_B = -0.4 \text{ A} \dots$	$V_{CE}(\text{sat})$	-	-1.5	-	max	V
$I_C = -0.7 \text{ A},$ $I_B = -0.02 \text{ A} \dots$	$V_{CE}(\text{sat})$	-2	-	-2	max	V
$I_C = -0.05 \text{ A},$ $I_B = -0.005 \text{ A} \dots$	$V_{CE}(\text{sat})$	-1	-	-	max	V

Base-to-Emitter Voltage

$I_C = -6 \text{ A}, I_B = -0.4 \text{ A}$	V_{BE}	-	0.7	-	typ	V
$I_C = -0.7 \text{ A},$ $I_B = -0.02 \text{ A} \dots$	V_{BE}	0.5	-	0.5	typ	V

Collector-Cutoff Current

$V_{CB} = -10 \text{ V}, I_E = 0$	I_{CB0}	-200	-200	-200	max	μA
-----------------------------------	-----------	------	------	------	-----	---------------

Turn-Off Time^{cd} t_{off}

		-	1.2	-	max	μs
--	--	---	-----	---	-----	---------------

Thermal Resistance. . . θ_{JC}

		1.5	1.5	1.5	max	$^{\circ}\text{C/W}$
--	--	-----	-----	-----	-----	----------------------

Junction-to-case

^a Measured at center of seating surface.

^b Measured at a distance not closer than 1/32 inch to seating surface.

^c "Turn-Off Time", as used for this transistor/damper-diode complement, is the time required for the Collector Current I_C to decrease to -100 milliamperes after the Collector-to-Emitter voltage V_{CE} has risen 2 volts into its "flyback" excursion. In a circuit of the type shown in the accompanying *Typical Horizontal-Deflection and High-Voltage Circuit* the collector current may be determined by measuring the base and emitter currents simultaneously with the aid of a current-transformer-type probe.

^d Test conditions for "Turn-Off Time" are given in the accompanying *Typical Horizontal-Deflection and High-Voltage Circuit*.

OPERATING CONSIDERATIONS

Because the metal shells of the 2N3730, 2N3731 and 2N3732 operate at the collector voltage, and that of the 1N4785 at the anode voltage, consideration should be given to the possibility of shock hazard if the shells are to operate at voltages appreciable above or below ground potential. In such cases, suitable precautionary measures should be taken.

These devices should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the device.



These devices can be installed in commercially available sockets. Electrical connection to the base and emitter pins may also be made by soldering directly to these pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals. Otherwise, the heat of the soldering operation will crack the pin seals and damage the transistor.

It is essential that the mounting flange which serves as the collector or anode terminal be securely fastened to a heat sink, which may be the equipment chassis. UNDER NO CIRCUMSTANCES, HOWEVER, SHOULD THE MOUNTING FLANGE BE SOLDERED TO THE HEAT SINK OR CHASSIS BECAUSE THE HEAT OF THE SOLDERING OPERATION WILL PERMANENTLY DAMAGE THE TRANSISTOR.

The mounting-flange temperature will be higher than the ambient (free-air) temperature by an amount which depends on the heat sink used. The heat sink must have sufficient thermal capacity to assure that the heat dissipated in the heat sink itself does not raise the device mounting-flange temperature above the design value.

Depending on the application, the heat sink or chassis may be connected to either the positive or negative terminal of the voltage supply.

In applications where the chassis is connected to the positive terminal of the voltage supply, it will be necessary to use either an anodized aluminum insulator having high thermal conductivity, or a mica insulator between the mounting flange and the chassis. To prevent a short circuit between the mounting bolts and the chassis, it is important that a fibre washer be used between each bolt and the chassis.

FOR ADDITIONAL INFORMATION ON THIS TYPE, WRITE FOR TECHNICAL BULLETIN AVAILABLE FROM:

Commercial Engineering
Electronic Components and Devices
Radio Corporation of America
Harrison, New Jersey

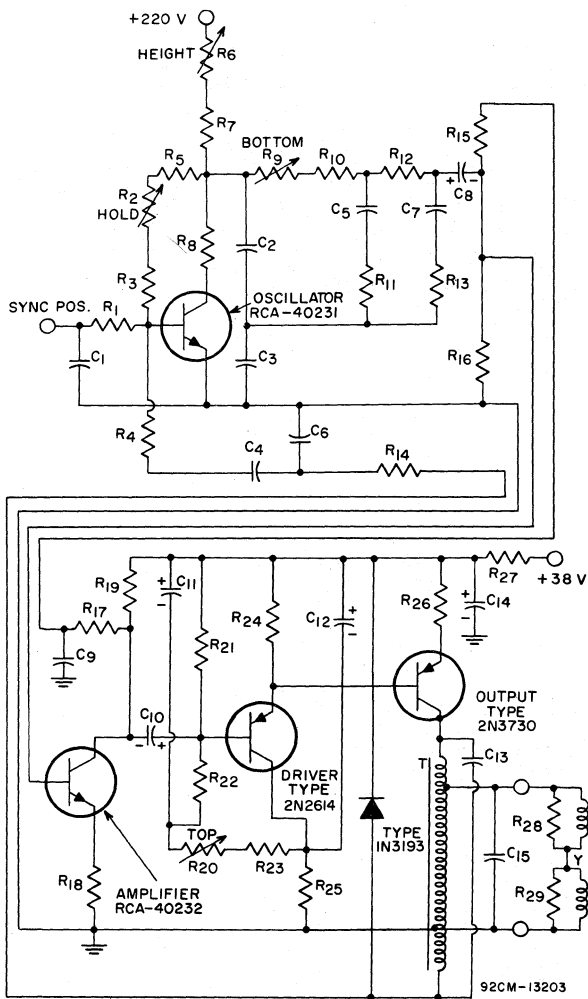
TYPICAL PERFORMANCE DATA FOR ACCOMPANYING HORIZONTAL-DEFLECTION AND HIGH-VOLTAGE CIRCUIT

DC Supply Voltage	+45	V
Average Supply Current.	0.55	A
Input Power		
Oscillator and driver circuits.	1.5	W
Output circuit:		
At beam current = 0	18	W
At beam current = 200 μ A.	22	W
Peak Collector-to-Emitter Voltage for Type 2N3731.	260	V
DC High-Voltage Output		
At beam current = 0	18	kV
At beam current = 200 μ A.	17	kV
Yoke Current (Peak-to-peak)	10	A
Peak Yoke Energy.	2.5	mJ
Retrace Time.	11.5	μ s



2N3730, 2N3731, 2N3732

TYPICAL VERTICAL DEFLECTION CIRCUIT 2N3730



C ₁ , C ₁₃ = 0.005 μ F	R ₇ = 270 K Ω
C ₂ = 1 μ F, paper	R ₈ = 220 Ω
C ₃ = 4 μ F, paper	R ₉ , R ₂₀ = Linearity control, potentiometer, 25 K Ω
C ₄ = 0.05 μ F	R ₁₀ = 22 K Ω
C ₅ , C ₇ = 0.25 μ F, paper	R ₁₁ , R ₁₃ = 4.7 K Ω
C ₆ = 0.02 μ F	R ₁₂ = 10 K Ω
C ₈ = 2 μ F, 25 V, electrolytic	R ₁₄ , R ₂₃ = 3.3 K Ω
C ₉ = 0.1 μ F	R ₁₅ = 150 K Ω
C ₁₀ , C ₁₁ , C ₁₂ = 25 μ F, 25 V, electrolytic	R ₁₆ , R ₁₇ = 100 K Ω
C ₁₄ = 500 μ F, 50 V, electrolytic	R ₁₈ = 470 Ω
C ₁₅ = 0.22 μ F	R ₁₉ = 2.7 K Ω
R ₁ = 15 K Ω	R ₂₁ = 1.5 K Ω
R ₂ = Hold control, potentiometer, 250 K Ω	R ₂₂ = 3.9 K Ω
R ₃ , R ₅ = 82 K Ω	R ₂₄ = 150 Ω
R ₄ = 18 K Ω	R ₂₅ = 680 Ω
R ₆ = Height control, potentiometer, 500 K Ω	R ₂₆ = 5.6 Ω
	R ₂₇ = 50 Ω , 10 W
	R ₂₈ , R ₂₉ = 56 Ω

T = Vertical-deflection output transformer: Better Coil & Transformer Corp., Goodlands, Ind. Part No. 99A20, or equivalent.

Y = Vertical-deflection windings of yoke: Inductance = 15 mH, resistance = 5 Ω .

All capacitors are disc ceramic type, unless otherwise specified.

All resistors are 0.5-watt, composition type, unless otherwise specified.

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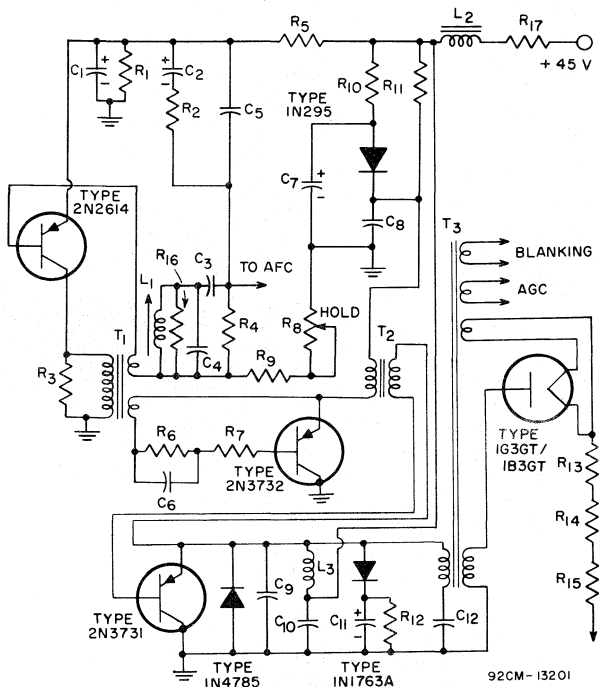


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Electronic Components and Devices Harrison, N. J.

DATA 3
9-65

2N3730, 2N3731, 2N3732

TYPICAL HORIZONTAL-DEFLECTION & HIGH-VOLTAGE CIRCUIT 2N3731, 2N3732, 1N4785



$C_1 = 50 \mu\text{F}$, 12 V, electrolytic
 $C_2 = 2 \mu\text{F}$, 3 V, electrolytic
 $C_3 = 0.008 \mu\text{F}$, mica
 $C_4 = 0.01 \mu\text{F}$, mica
 $C_5 = 0.2 \mu\text{F}$
 $C_6 = 0.1 \mu\text{F}$, 3 V
 $C_7 = 10 \mu\text{F}$, 15 V, electrolytic
 $C_8 = 0.05 \mu\text{F}$, 50 V
 $C_9 = 0.05 \mu\text{F}$, 300 V
 $C_{10} = 4 \mu\text{F}$, 25 V
 $C_{11} = 10 \mu\text{F}$, 300 V, electrolytic
 $C_{12} = 0.15 \mu\text{F}$, 400 V

L_1 = Sine-wave coil
 L_2 = Choke, 2 mH at 2 A
 L_3 = Horizontal-deflection windings
 of yoke — Inductance = $200 \mu\text{H}$

$R_1, R_{16} = 560 \Omega$
 $R_2 = 2.2 \text{ K}\Omega$
 $R_3, R_5 = 1 \text{ K}\Omega$
 $R_4 = 15 \text{ K}\Omega$
 $R_6 = 4.7 \Omega$
 $R_7 = 10 \Omega$
 R_8 = Hold control, potentiometer,
 $10 \text{ K}\Omega$
 $R_9 = 22 \text{ K}\Omega$
 $R_{10} = 2.7 \text{ K}\Omega$
 $R_{11} = 560 \Omega$, 1 W
 $R_{12} = 1 \text{ M}\Omega$
 $R_{13}, R_{14}, R_{15} = 27 \text{ K}\Omega$
 $R_{17} = 15 \Omega$, 10 W
 T_1 = Blocking-oscillator transformer
 T_2 = Driver transformer
 T_3 = Horizontal-deflection output
 and high-voltage transformer



Transistor

SILICON N-P-N "OVERLAY" EPITAXIAL-PLANAR TYPE

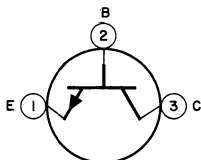
For Large-Signal High-Power VHF-UHF Applications in Military and Industrial Communications Equipment. Intended for Class-A, -B, -C Amplifier, Frequency Multiplier, or Oscillator Service

Dimensions See Outline TO-60 in General Section

Terminal Diagram:

BOTTOM VIEW

Pin 1—Emitter
Pin 2—Base



Pin 3—Collector

RADIO-FREQUENCY SERVICE

MAXIMUM RATINGS, Absolute-Maximum Values

Collector-to-Base Voltage.	V_{CBO}	65	V
Collector-to-Emitter Voltage			
With $V_{BE} = -1.5$ V.	V_{CEV}	65	V
With base open	V_{CEO}	40	V
Emitter-to-Base Voltage.	V_{EBO}	4	V
Peak Collector Current		3	A
Transistor Dissipation			
At case temperatures:			
From -65 to 25°C	P_T	23	W
Above 25°C	Derate linearly to 0 watts at 200°C		
Temperature Range			
Operating (Junction)	T_{opr}	-65 to 200	$^{\circ}\text{C}$
Storage.	T_{stg}	-65 to 200	$^{\circ}\text{C}$
Pin-Soldering Temperature ^a	T_p	230	$^{\circ}\text{C}$
(For 10 sec. max.)			

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode voltage and electrode-current values for given test conditions are dc at case temperature = 25°C

	Min	Typ	Max	
Collector-to-Base Breakdown Voltage	BV_{CBO}	65	-	V
$I_C = 0.5$ mA, $I_E = 0$				
Collector-to-Emitter Breakdown Voltage				
I_C (Pulsed) = 0 to 200 mA ^b , $V_{BE} = -1.5$ V.	BV_{CEV}	65°C	-	V
I_C (Pulsed) = 0 to 200 mA ^b , $I_B = 0$	BV_{CEO}	40°C	-	V



RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Harrison, N. J.

DATA 1
5-65

Min Typ Max

Emitter-to-Base

Breakdown Voltage	BV_{EBO}	4	-	-	V
$I_E = 0.25 \text{ mA}, I_C = 0$					

Collector-to-Emitter

Saturation Voltage.	$V_{CE(sat)}$	-	-	1	V
$I_C = 0.5 \text{ A}, I_B = 100 \text{ mA}$					

Collector-Cutoff Current . . .

	I_{CE0}	-	-	0.25	mA
$V_{CE} = 30 \text{ V}, I_B = 0$					

Base-Spreading Resistance. . .

	$r_{bb'}$	-	6.5	-	Ω
$f = 200 \text{ Mc/s}, V_{CE} = 28 \text{ V}, I_C = 250 \text{ mA}$					

Output Capacitance

	C_{ob}	-	-	20	pF
$f = 1 \text{ Mc/s}, V_{CB} = 30 \text{ V}, I_E = 0$					

Collector-to-Case Capacitance.

	C_s	-	-	6	pF
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Gain-Bandwidth Product

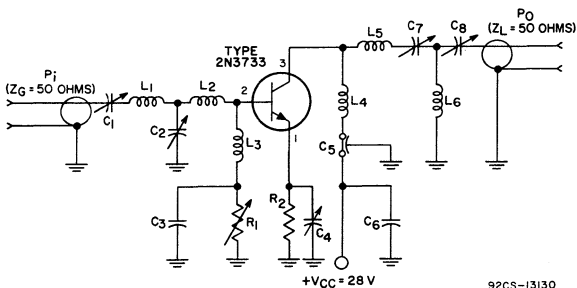
	f_T	-	400	-	Mc/s
$V_{CE} = 28 \text{ V}, I_C = 150 \text{ mA}$					

RF Power Output Amplifier, Unneutralized^d $V_{CE} = 28 \text{ V}, P_i = 4 \text{ W},$

$f = 260 \text{ Mc/s}$	P_o	-	14.5 ^e	-	W
$f = 400 \text{ Mc/s}$	P_o	10 ^f	-	-	W

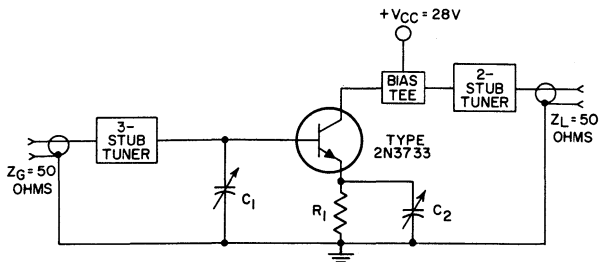
^a Measured along pin at distances not less than 1/32" from ceramic wafer.^b Pulsed through an inductor (25 mH); duty factor = 0.5.^c Measured at a current where the breakdown voltage is a minimum.^d See accompanying *Power-Output-Measurement Circuits*.^e For conditions given, minimum efficiency = 60 per cent.^f For conditions given, minimum efficiency = 45 per cent.

POWER OUTPUT MEASUREMENT CIRCUITS Unneutralized RF Amplifier, 260-Mc



- | | |
|--|---|
| C ₁ : 3-35 pF | L ₃ : Ferrite choke, Z = 450 Ω |
| C ₂ , C ₄ , C ₈ : 8-60 pF | L ₄ : RF choke, 0.47 μ H |
| C ₃ , C ₆ : 0.005 μ F disc ceramic | L ₅ : 3-1/2 turns No. 16 wire, 1/4" ID, 7/16" long |
| C ₅ : 1,000 pF | L ₆ : 1 turn No. 16 wire, 1/4" ID, 3/8" long |
| C ₆ : 1.5-20 pF | R ₁ : 50 Ω |
| L ₁ : 3 turns No. 18 wire, 1/4" ID, 1/4" long | R ₂ : 0.56 Ω |
| L ₂ : 3/16" wide copper strip, 3/8" long | |

Unneutralized RF Amplifier, 400-Mc



C₁, C₂: 7.8-17 pF

R₁: 0.56 Ω

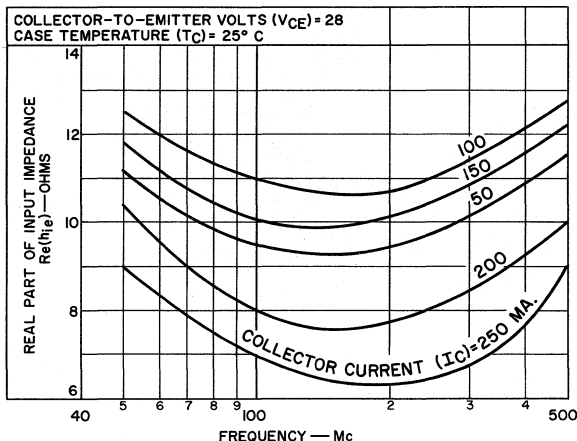


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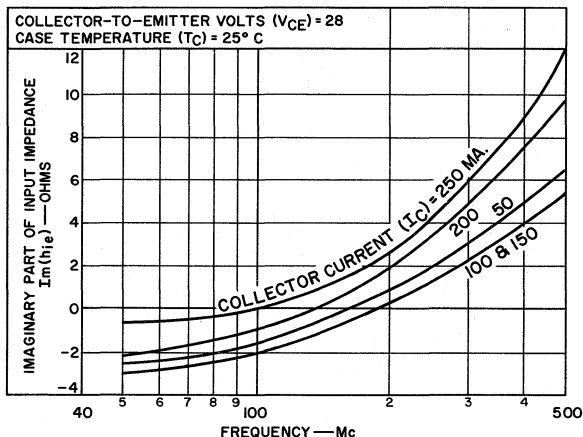
Harrison, N. J.

DATA 2
5-65

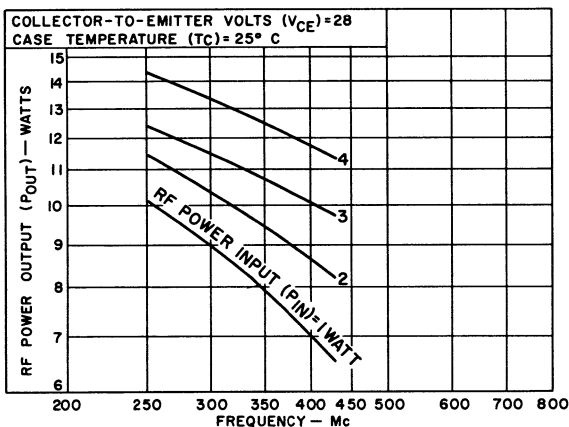
Series Input Resistance vs. Frequency



Series Input Reactance vs. Frequency

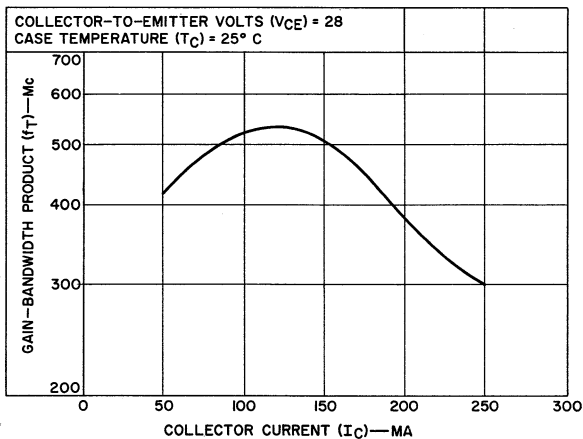


Power Output vs. Frequency



92CS-13134

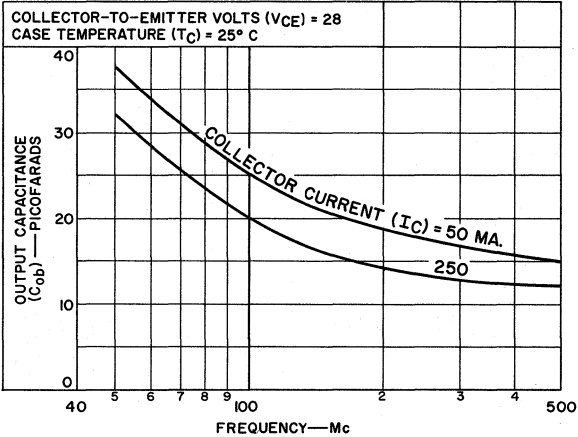
Gain-Bandwidth Product vs. Collector Current



92CS-12830

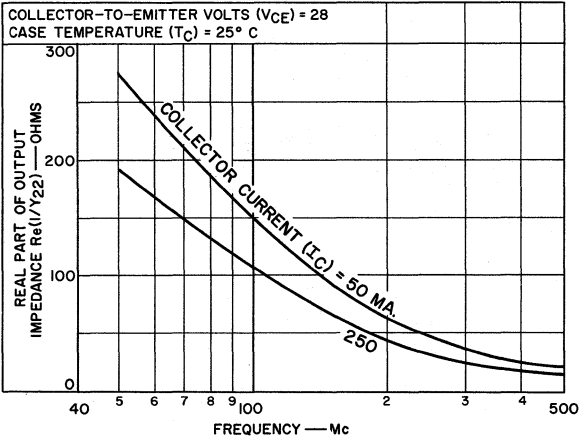


Output Capacitance vs. Frequency



92CS-12832

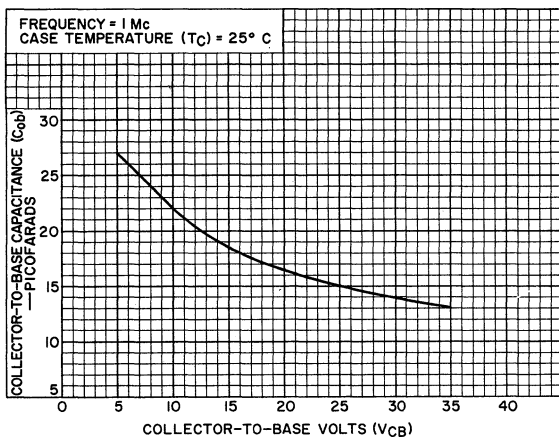
Output Resistance vs. Frequency



92CS-12840



Variation of Collector-to-Base Capacitance



92CS-12831

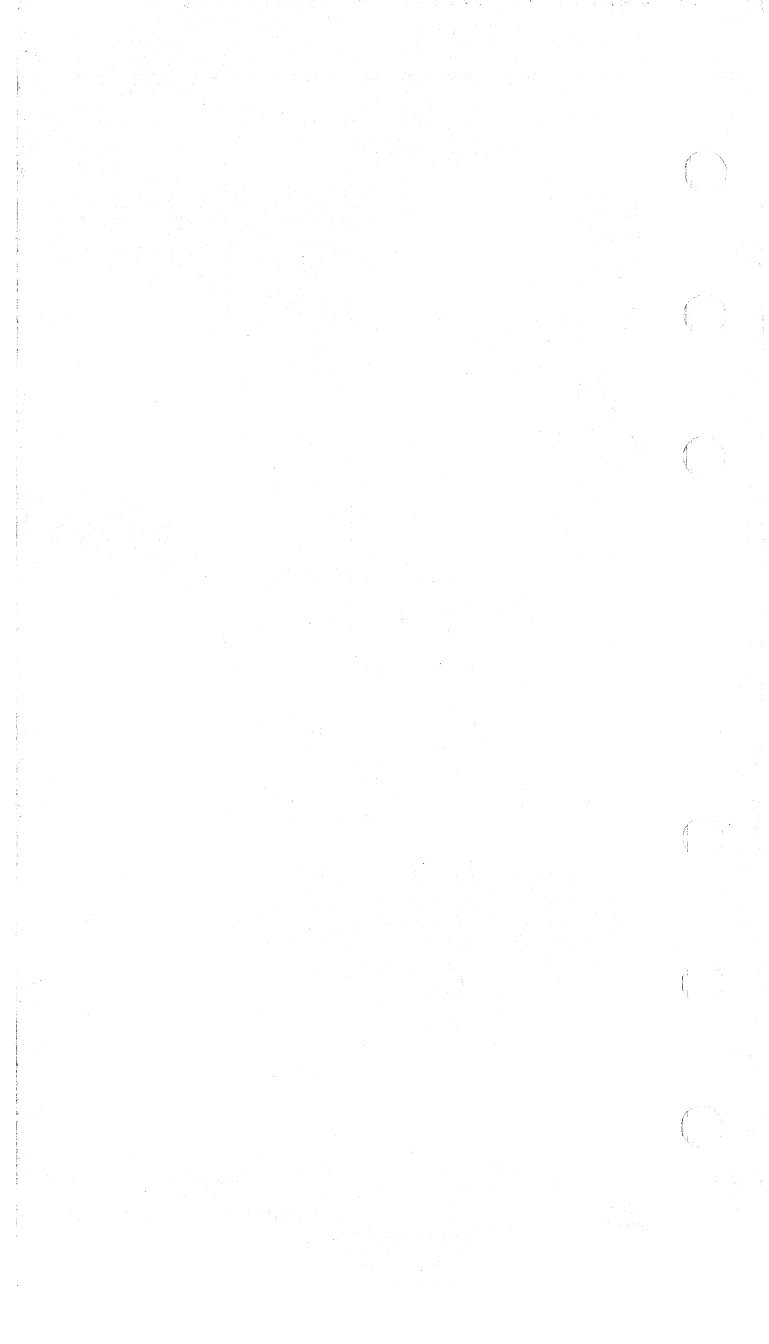
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DATA 4
5-65



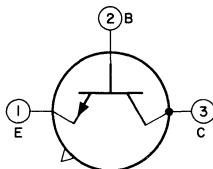
Transistor

SILICON N-P-N "OVERLAY" EPITAXIAL-PLANAR TYPE

For Output, Driver, or Pre-Driver Stages in VHF-UHF Applications in Military and Industrial Communications Equipment. Intended for Class-A, -B, or -C Amplifier, Frequency-Multiplier, or Oscillator Service

Dimensions See Outline TO-39 in General Section
Terminal Diagram BOTTOM VIEW

Lead 1 - Emitter
Lead 2 - Base



Lead 3 - Collector,
Case

RADIO-FREQUENCY SERVICE

Maximum Ratings, Absolute-Maximum Values

Collector-to-Base Voltage.	V_{CB0}	55	V
Collector-to-Emitter Voltage			
RBE = 10 Ω (External Resistance).	V_{CER}	55	V
Base open.	V_{CEO}	30	V
Emitter-to-Base Voltage.	V_{EB0}	3.5	V
Collector Current.	I_C	0.4	A
Transistor Dissipation			
At case temperatures:			
From -65 to 25°C	P_T	5	W
Above 25°C	Derate linearly to 0 W at 200°C		
Temperature Range			
Operating (Junction)	T_{opr}	-65 to 200	°C
Storage.	T_{stg}	-65 to 200	°C
Lead-Soldering Temperature ^a	T_L	230	°C
(For 10 sec. max.)			

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode voltage and electrode-current values for given test conditions are dc at case temperature = 25°C

		Min	Typ	Max	
Collector-to-Base					
Breakdown Voltage	BV_{CB0}	55	-	-	V
$I_C = 0.1$ mA, $I_E = 0$					
Emitter-to-Base					
Breakdown Voltage	BV_{EB0}	3.5	-	-	V
$I_E = 0.1$ mA, $I_C = 0$					
Collector-to-Emitter					
Sustaining Voltage					
$I_C = 5$ mA.	$V_{CER(sus)}$	55	-	-	V
$I_C = 5$ mA, $I_B = 0$	$V_{CEO(sus)}$	30	-	-	V



2N3866

Collector-to-Emitter

Saturation Voltage $V_{CE(sat)}$

$I_C = 100$ mA, $I_B = 20$ mA

Collector-Cutoff Current I_{CEO}

$V_{CE} = 28$ V, $I_B = 0$

Output Capacitance C_{ob}

$f = 1$ Mc/s, $V_{CB} = 30$ V, $I_E = 0$

Gain-Bandwidth Product f_T

$V_{CE} = 15$ V, $I_C = 25$ mA

RF Power Output Amplifier,

Unneutralized

$f = 100$ Mc/s, $V_{CC} = 28$ V,

$P_i = 0.05$ W. P_o - 1.8^b - W

$f = 250$ Mc/s, $V_{CC} = 28$ V,

$P_i = 0.1$ W. P_o - 1.5^c - W

$f = 400$ Mc/s,^e $V_{CC} = 28$ V,

$P_i = 0.1$ W. P_o 1^d - - W

Min Typ Max

^a Measured along lead at distances $\geq 1/32$ inch from seating plane.

^b For conditions given, minimum efficiency = 60 per cent.

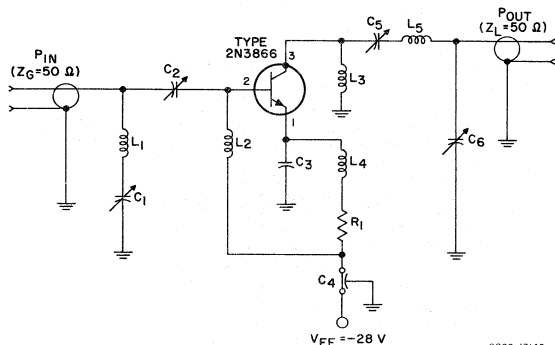
^c For conditions given, minimum efficiency = 50 per cent.

^d For conditions given, minimum efficiency = 45 per cent.

^e See accompanying Power-Output Measurement Circuit.

POWER-OUTPUT MEASUREMENT CIRCUITS

Unneutralized RF Amplifier, 400-Mc/s



92CS-13145

C1: 3-35 pF

C2, C5: 8-60 pF

C3: 12 pF

C4: 1,000 pF

C6: 0.9-7 pF

L1: 2 turns No. 18 wire,
1/4" ID, 1/8" long

L2: Ferrite rf choke,

1 turn, Z = 450 ohms

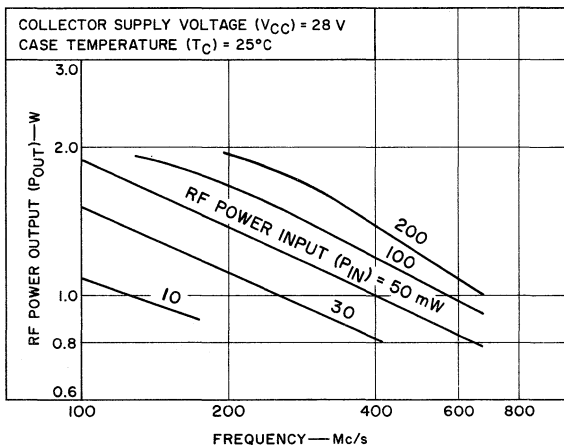
L3, L4: RF choke, 0.1 microH

L5: 2-1/2 turns, No. 18 wire,
1/4" ID, 3/16" long

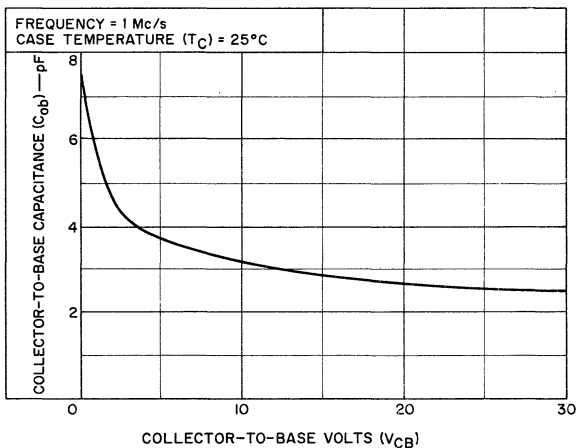
R1: 5.6 ohms, 1 W



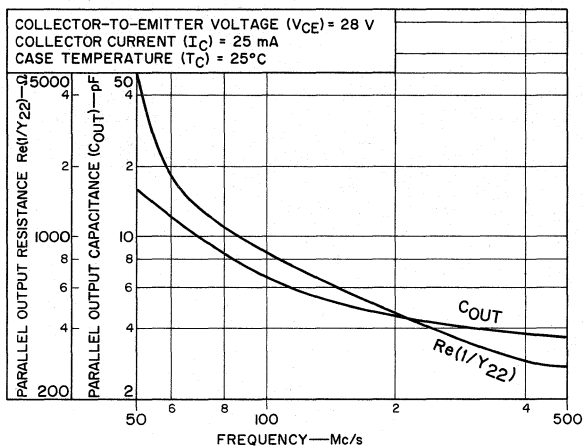
Power Output vs. Frequency



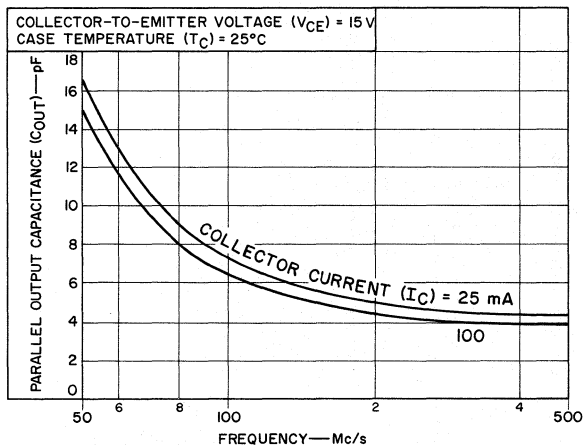
Variation of Collector-to-Base Capacitance



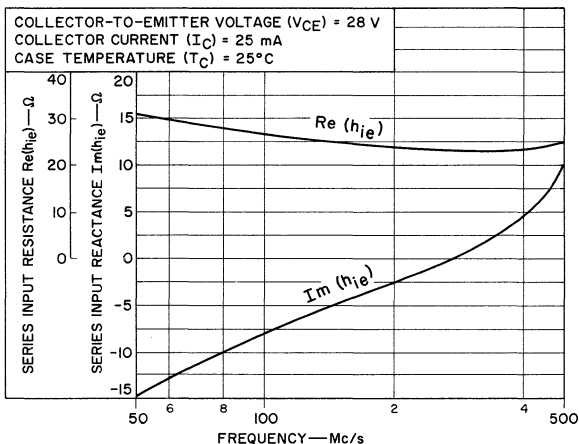
Parallel Output Resistance & Capacitance vs. Frequency



Parallel Output Capacitance vs. Frequency

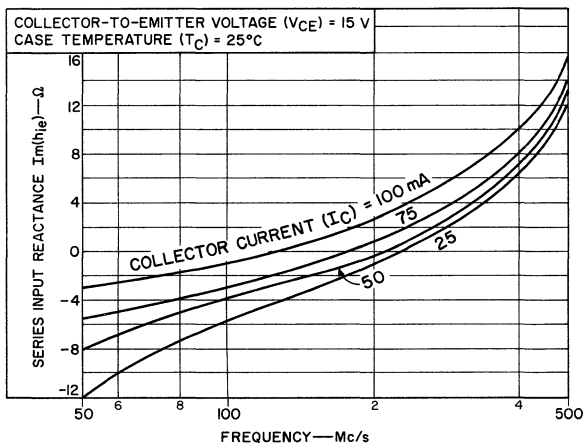


Series Input Resistance & Reactance vs. Frequency



92CS-13147

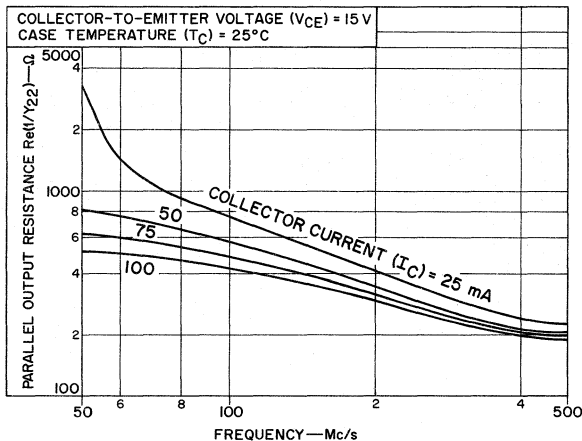
Series Input Reactance vs. Frequency



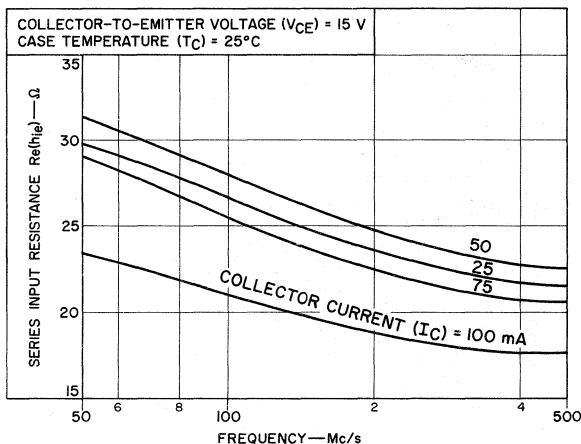
92CS-13151



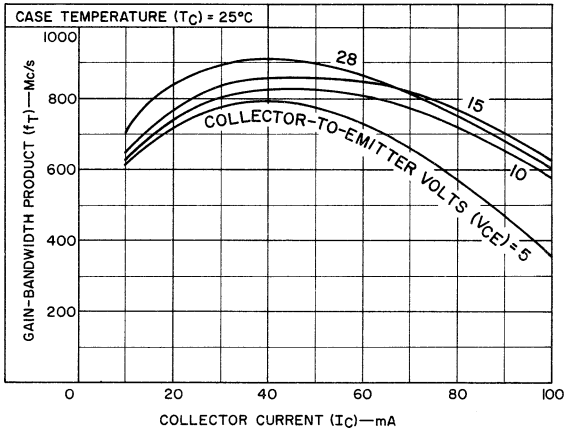
Parallel Output Resistance vs. Frequency

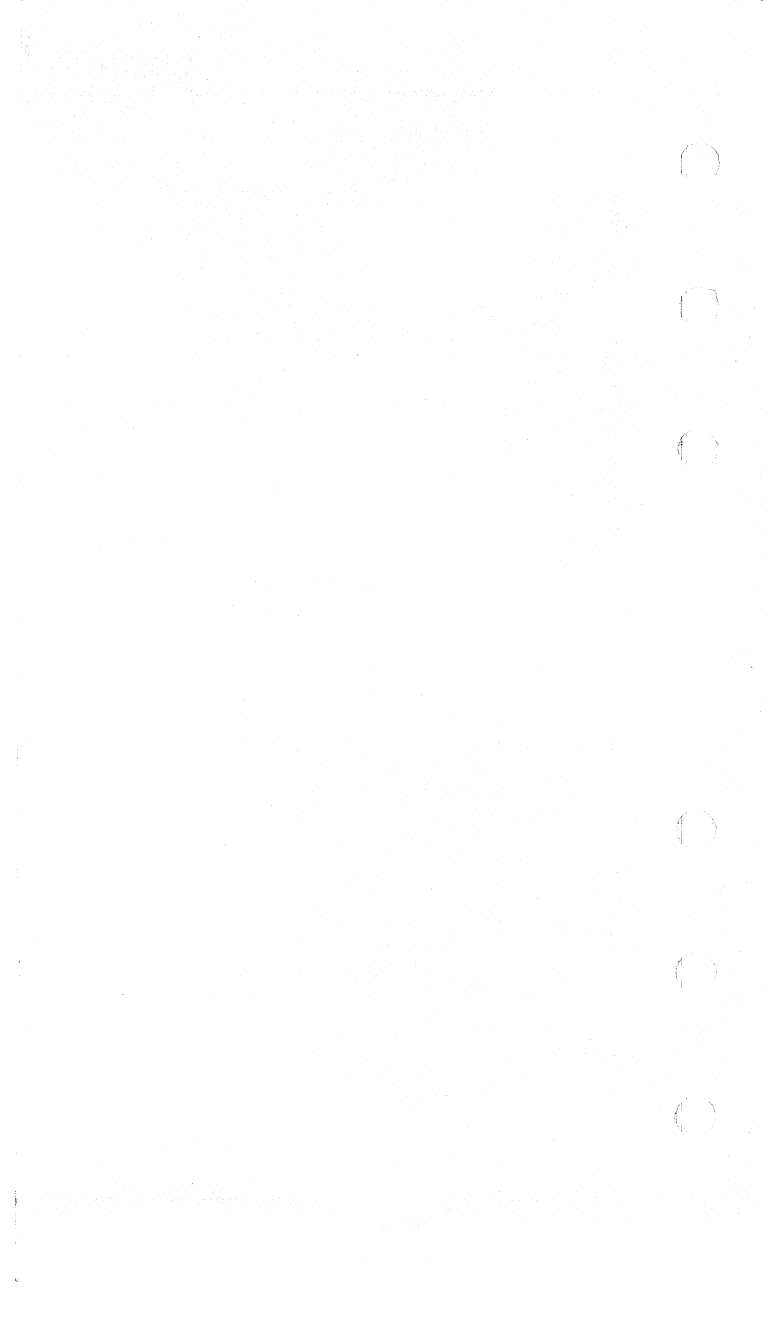


Series Input Resistance vs. Frequency



Gain-Bandwidth Product vs. Collector Current





Silicon Controlled Rectifiers

Also known as reverse-blocking triode thyristors

N-P-N-P ALL-DIFFUSED, 3-JUNCTION TYPES

PRESS-FIT MOUNTING TYPES

2N3870-For Low-Voltage Power Supplies

2N3871-For 120-Volt Line Operation

2N3872-For 240-Volt Line Operation

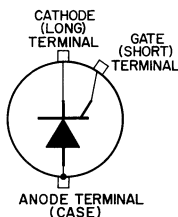
2N3873-For High-Voltage Power Supplies

For Use in Power-Control and Power-Switching Applications

MECHANICAL

Dimensions See accompanying *Dimensional Outline*

TERMINAL DIAGRAM (Bottom View)



The arrow is in the direction of forward current

ABSOLUTE-MAXIMUM RATINGS^a

For Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 c/s, and with Resistive or Inductive Load

	2N3870	2N3871	2N3872	2N3873	
V_{RM} (rep) ^a (gate open) . . .	100	200	400	600	V
V_{RM} (non-rep) (gate open) . .	150	330	660	700	V
V_{FBOM} (rep) (gate open) . . .	700	700	700	700	V
I_{FAV}					
At a conduction angle of 180°, $T_C = 65^\circ C$	22	22	22	22	A
For other conditions . . .	See Rating Chart (Case Temperature)				
I_{FRMS}					
At $T_C = 65^\circ C$	35	35	35	35	A
For other conditions . . .	See Rating Chart (Case Temperature)				
I_{FM} (surge)					
For 1 cycle of applied voltage	350	350	350	350	A
For more than 1 cycle of applied voltage	See Peak-Surge Current Rating Chart				
di/dt^b	200	200	200	200	A/ μs
$V_{FB} = V_{B00}$ (min value)					
$I_{GT} = 200$ mA, 0.5 μs min. rise time					

^a Terms for symbols are given at end of data; definitions for these terms and symbols are given in General Section of the Handbook.



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DATA 1
12-65

2N3870 to 2N3873

	2N3870	2N3871	2N3872	2N3873	
P_{GM}^{cd}	40	40	40	40	W
Forward or Reverse for duration of 10 μs					
P_{GAY}	0.5	0.5	0.5	0.5	W
T_C (opr)	-40 to 100				$^{\circ}C$
T_{STG}	-40 to 125				$^{\circ}C$

CHARACTERISTICS

At Maximum Ratings, Unless Otherwise Specified

	2N3870	2N3871	2N3872	2N3873		
V_{B00}	100	200	400	600	min	V
$T_C = 100^{\circ}C$						
V_F^a	1.7	1.7	1.7	1.7	typ	V
$I_F = 100$ A, $T_C = 25^{\circ}C$	2.1	2.1	2.1	2.1	max	V
V_F (initial) ^f	15	15	15	15	typ	V
$I_F = 300$ A, $t = 2 \mu s$,	25	25	25	25	max	V
$V_{FB} = V_{B00}$ (min. value), $I_{GT} = 200$ mA						
V_{GT}^g	1.1	1.1	1.1	1.1	typ	V
$T_C = 25^{\circ}C$	2	2	2	2	max	V
dv/dt^h (critical rate) {	10	10	10	10	min	V/ μs
$V_{FB} = V_{B00}$ (min. value), exponential rise, $T_C = 100^{\circ}C$	100	100	100	100	typ	V/ μs
i_{FBOM}	0.2	0.25	0.3	0.35	typ	mA
Forward, $V_{FB0} = V_{B00}$ (min. value), $T_C = 100^{\circ}C$	2	2.5	3	4	max	mA
i_{RBOM}	3	3	3	3	max	mA
Reverse, $V_{RBOM} =$ V_{RM} (rep) value						
I_{GT}^g	1	1	1	1	min	mA
$T_C = 25^{\circ}C$	25	25	25	25	typ	mA
	40	40	40	40	max	mA
i_{H00}	0.5	0.5	0.5	0.5	min	mA
$T_C = 25^{\circ}C$	20	20	20	20	typ	mA
	70	70	70	70	max	mA
t_{on}^j	0.75	0.75	0.75	0.75	min	μs
$V_{FB} = V_{B00}$ (min. value), $I_F = 30$ A, $I_{GT} = 200$ mA, 0.1 μs min rise time, $T_C = 25^{\circ}C$	1.25	1.25	1.25	1.25	typ	μs
	2	2	2	2	max	μs

^a Terms for symbols are given at end of data; definitions for these terms and symbols are given in General Section of the Handbook.



2N3870 2N3871 2N3872 2N3873

t_{off}^k	{	15	15	15	15	min	μs
$i_F = 18 A$, 50 μs pulse width, $dv_{FB}/dt = 20 V/\mu s$, $di_F/dt = 30 A/\mu s$, $I_{GT} = 200 mA$, $T_C = 80^\circ C$	{	20	20	20	20	typ	μs
	{	40	40	40	40	max	μs

- a Terms for symbols are given at end of data; definitions for these terms and symbols are given in General Section of the Handbook.
- b See accompanying *Waveshape of di/dt Rating Test*.
- c Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.
- d See accompanying *Forward and Reverse Gate Characteristics*.
- e See accompanying *Forward Characteristics*.
- f See accompanying *Waveshape of v_f (initial) Rating Test*.
- g See accompanying *Forward Gate Characteristics*.
- h See accompanying *Waveshape of Critical dv/dt Rating Test*.
- j See accompanying *Waveshape of t_{on} Rating Test*.
- k See accompanying *Waveshape of t_{off} Rating Test*.

SYMBOLS AND TERMS

The transistor symbols are listed alphabetically with their associated terms. Unless otherwise specified definitions for the Symbols and Terms are given in General Section of Handbook.

di/dt Rate of Change of Forward Current - The maximum rate of change of current which may be imposed on the device immediately after turn on by the gate from a forward blocking condition.

Critical dv/dt Critical Rate of Applied Forward Voltage - The critical rate of applied forward voltage is the minimum value of the rate of applied forward voltage which will cause switching from the off-stage to the on-stage under stated conditions.

I_{FBOM} Peak Forward Blocking Current - The maximum value of the forward blocking current of a controlled rectifier with gate open.

$I_{FM}(\text{surge})$ Peak Surge Current

I_{H00} Holding Current

I_{RBOM} Peak Reverse Blocking Current - The maximum value of the reverse blocking current of a controlled rectifier with gate open

I_{FAV} Average forward Current

I_{FRMS} RMS Forward Current - The RMS value of the current flowing from anode to cathode in the device.

I_{GT} Gate-Trigger Current

P_{GM} Peak Forward and Reverse Gate Power

P_{GAV} Average Forward Gate Power



2N3870 to 2N3873

t_{off}	Turn-Off Time (Reverse Recovery Time + Gate Recovery Time) - Turn-off time is the time interval between the time when the forward current decreases to zero and the time when the device anode voltage reaches zero and is rising to a stated value of forward blocking voltage at a stated rate of rise without turning on during switching in the external anode circuit from the on-state to the off-state under stated conditions.
t_{on}	Turn-On Time (Delay Time + Rise Time) - Turn-on time is the time interval between the initiation of the gate signal and the time when the resulting forward current reaches 90 per cent of its maximum value during switching from the off-state to the on-state under stated conditions.
V_{B00}	Forward Breakover Voltage
V_F	Instantaneous Forward Voltage Drop
$V_F(\text{initial})$	Initial Forward Voltage Drop - The instantaneous forward voltage drop across a controlled rectifier at a given instantaneous forward current and at a specified time after turn on from a forward blocking condition.
$V_{FB0M}(\text{rep})$	Peak Forward Blocking Voltage (Repetitive)
$V_{RM}(\text{non-rep})$	Transient Peak Reverse Voltage (Non-Repetitive)
$V_{RM}(\text{rep})$	Peak Reverse Voltage (Repetitive)
V_{FB0}, V_{RBO}	Forward and Reverse Blocking Voltage - The value of voltage applied between anode and cathode with the gate open.
V_{GT}	Gate-Trigger Voltage

TRIGGERING CONSIDERATIONS

The construction of the gate-cathode junction used in these devices provides a large periphery center gate and employs shorted-emitter design which removes restrictions on both forward and reverse peak gate voltage and peak gate current. Limiting values of volt-ampere products for different gate pulse widths are shown under *Forward Gate Characteristics*. These limits should be adhered to when designing pulse trigger circuits for maximum trigger pulse widths and peak power dissipation. The volt-ampere products in the reverse direction shown under *Reverse Gate Characteristics* should be used to determine limitations for reverse gate transients or reverse gate pulses if present. In all cases, total average gate dissipation, both forward and reverse, should not exceed the average gate dissipation rating (P_{GAY}) of 0.5 watt.

Turn-on times for different gate currents are shown under *Turn-On Time Characteristics*. These curves may be used to determine the required width of the gate trigger pulses. It is only necessary to maintain the gate trigger pulse until the



magnitude of the forward anode current has reached the latching current value. However, conservative design requires that the gate trigger pulse width be at least equal to or somewhat greater than the device turn-on time. Some applications may require wider gate pulse widths for proper circuit operation. Additional information on gate characteristics and triggering requirements for use in pulse applications are contained in RCA Application Note, SMA-39, "Gate Parameters of RCA SCR's for Trigger Circuit Design".

COOLING CONSIDERATIONS

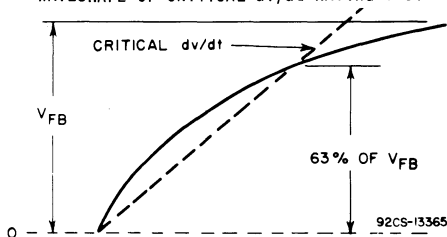
The overall thermal resistance of the heat sink, case to air, needed to operate these devices at a given current and a specific ambient air temperature is shown under curve *Cooling Considerations*. For example: for a forward current of 10 amperes and an ambient air temperature of 45° C (113° F), the required thermal resistance of the heat sink, case to air, is 3° C/W. This includes both case-to-heat sink and heat sink-to-air thermal resistances.

Typical values of case-to-heat sink thermal resistances for different mounting arrangements are shown under *Case-to-Heat Sink Thermal Resistance for Different Mounting Arrangements*. Thermal resistance characteristics of commercial heat sinks are contained in various manufacturers' data sheets. For guidance purposes, the required sizes of typical, square, 1/8"-thick, aluminum fins having dull surfaces for different thermal resistance values are also shown under curve *Cooling Considerations*. These sizes apply for stud-mounted types mounted without insulating hardware.

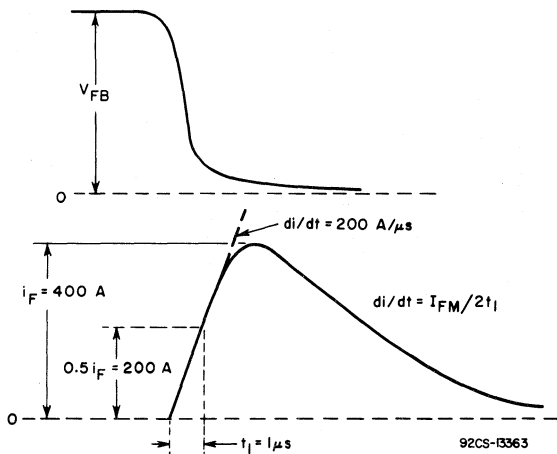
CASE-TO-HEAT SINK THERMAL RESISTANCES

Device Types	Type of Mounting Employed	Thermal Resistance
2N3870 through 2N3873	Press-fitted into heat sink. (Minimum Required thickness of heat sink = 1/8").	0.5° C/W
	Soldered directly to heat sink. (60-40 solder which has a melting point of 188° C should be used. Exposure time should be sufficient to cause solder to flow freely).	0.35° C/W

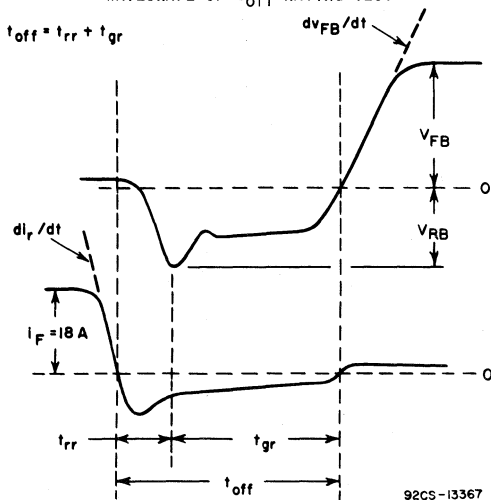
WAVESHAPE OF CRITICAL dv/dt RATING TEST



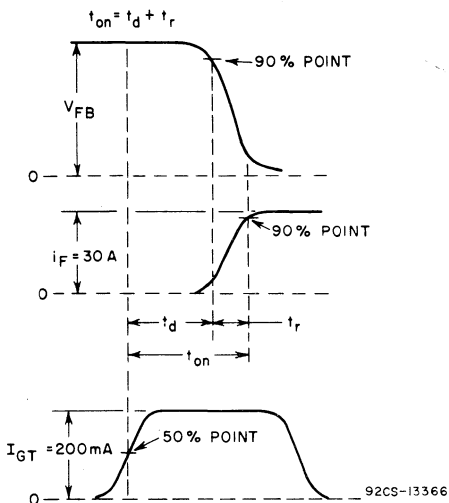
WAVESHAPE OF di/dt RATING TEST



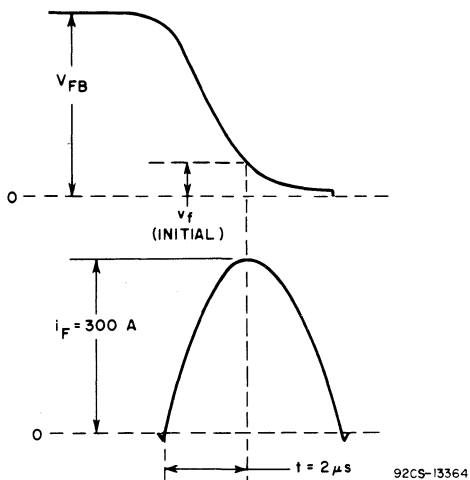
WAVESHAPE OF t_{off} RATING TEST



WAVESHAPE OF t_{on} RATING TEST

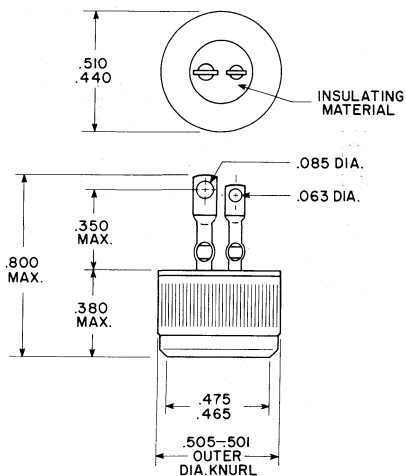


WAVESHAPE OF v_f (initial) RATING TEST



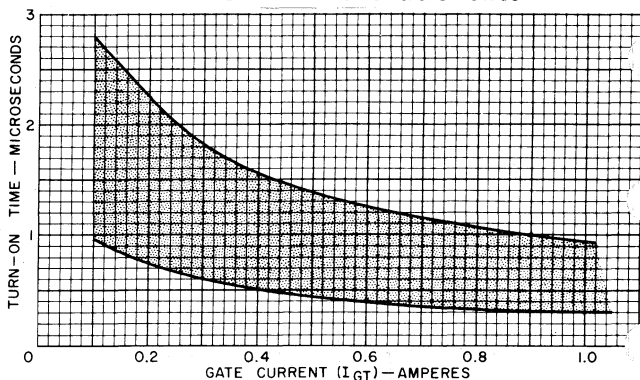
2N3870 to 2N3873

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

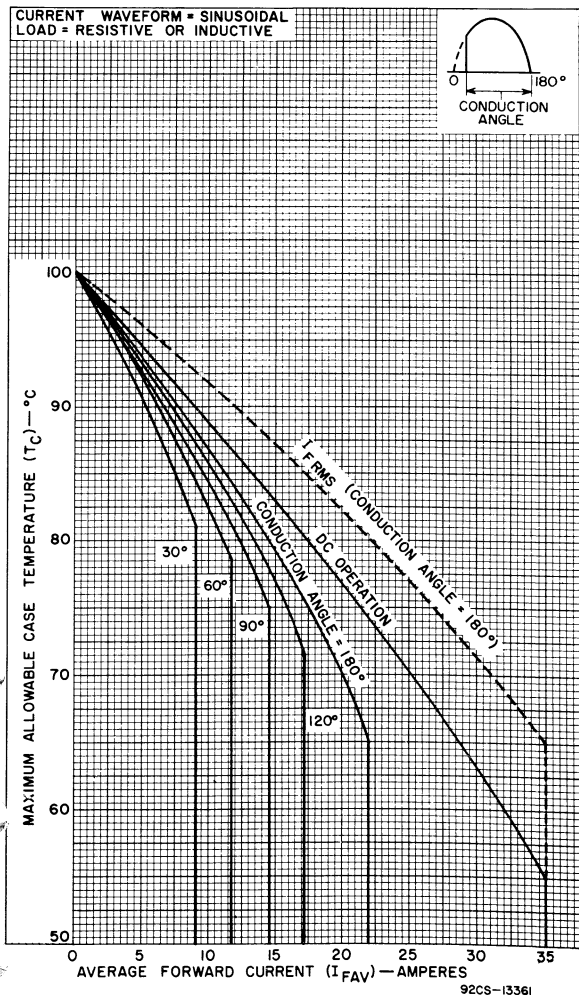
Turn-On Time Characteristics



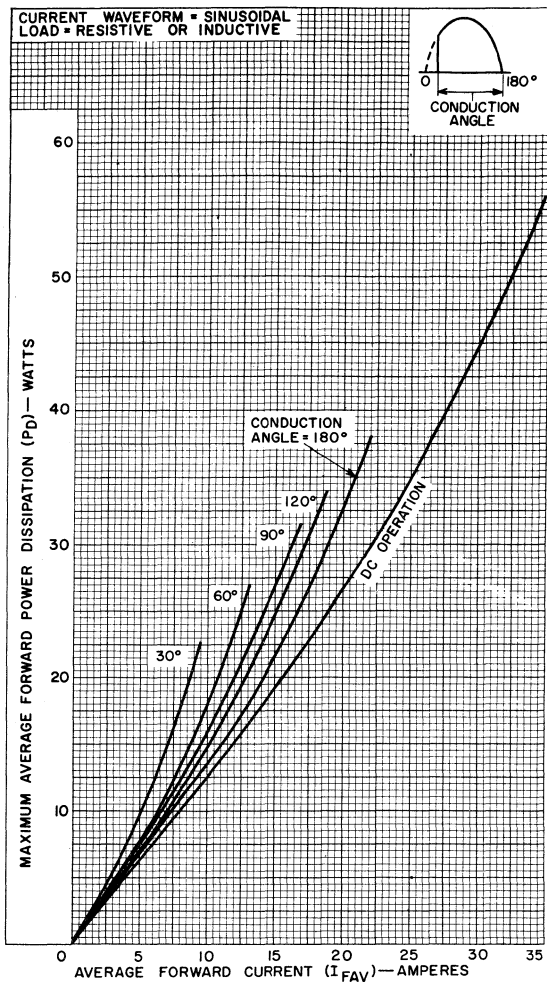
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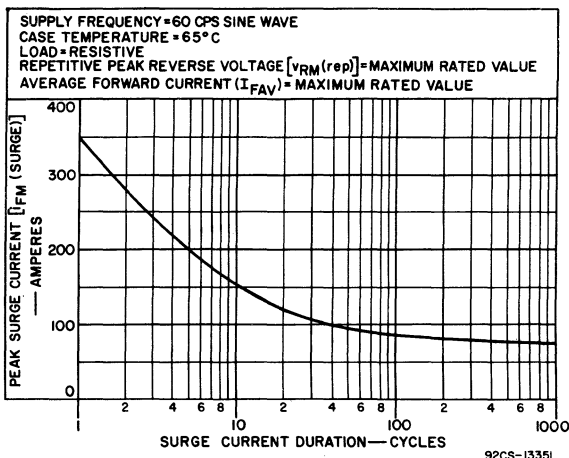
Rating Chart (Case Temperature)



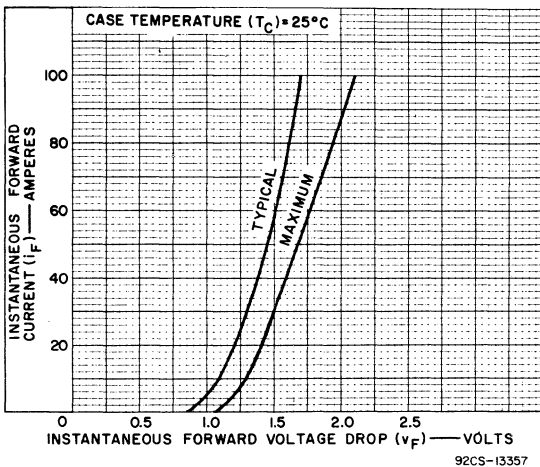
Power Dissipation



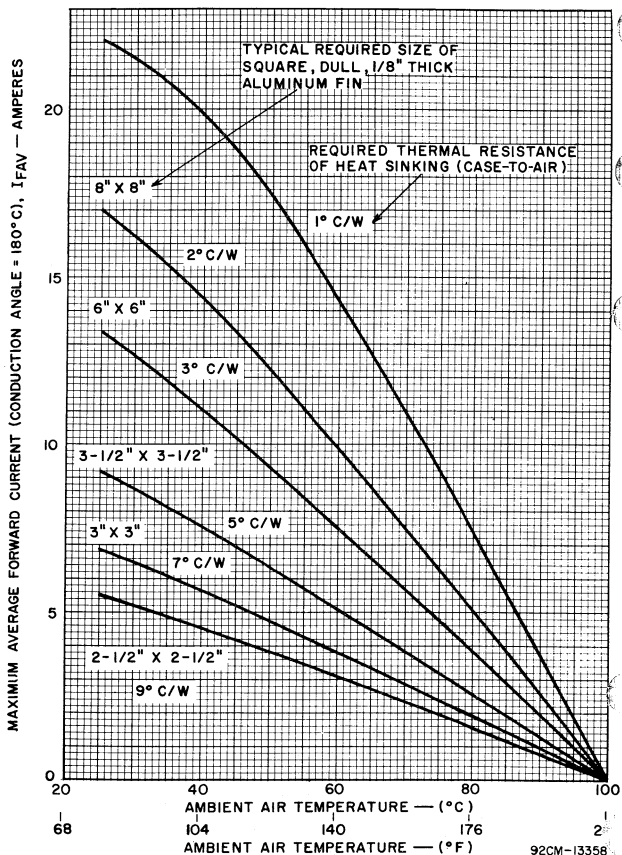
Peak-Surge Current Rating Chart



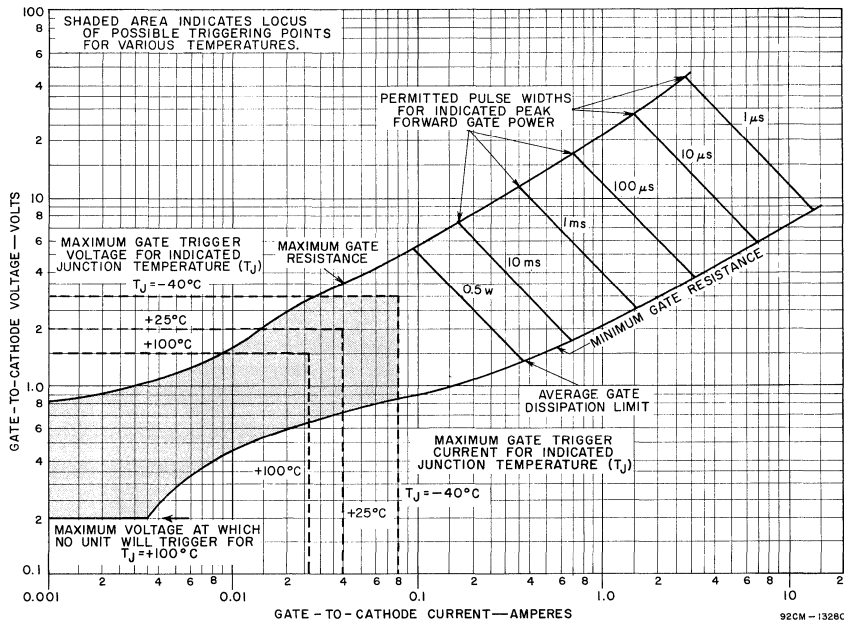
Forward Characteristics



Heat Sink Guidance



Forward Gate Characteristics



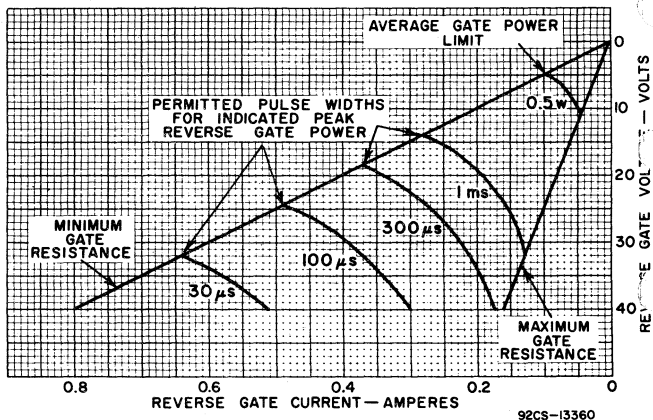
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DATA 7
12-65

Reverse Gate Characteristics



2N3771, 2N3772, 2N3773

Power Transistors

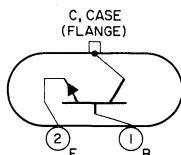
SILICON N-P-N TYPES

4- TO 25-AMPERE OPERATING COLLECTOR CURRENT

*For Intermediate- and High-Power Applications Including Use in
Public-Address Amplifiers, Power Supplies, and Low-Speed
Switching Regulators and Inverters*

Dimensions See Outline TO-3 in General Section
Terminal Diagram BOTTOM VIEW

Pin 1 - Base
Pin 2 - Emitter



Mounting Flange-
Collector, Case

ABSOLUTE-MAXIMUM RATINGS

		2N3771	2N3772	2N3773	
Collector-to-Base Voltage . . .	V_{CB0}	50	100	160	V
Collector-to-Emitter Voltage					
With $V_{BE} = -1.5$ V	V_{CEV}	50	100	160	V
With base open	V_{CEO}	40	60	140	V
Emitter-to-Base Voltage	V_{EB0}	5	7	7	V
Collector Current	I_C	30	30	30	A
Transistor Dissipation					
At case temperatures:					
Up to 25°C.	P_T	150	150	150	W
Above 25°C.		See Dissipation Derating Chart			
Temperature Range					
Operating (Junction).	$T_{(opr)}$	-65 to 200			°C
Storage	$T_{(stg)}$	-65 to 200			°C
Pin-Soldering Temperature ^a . . .		230	230	230	°C
For 10 sec. max					

ELECTRICAL CHARACTERISTICS

*Unless otherwise specified, electrode voltage and electrode-current values
for given test conditions are dc at case temperature = 25°C*

		2N3771	2N3772	2N3773	
Emitter-to-Base Breakdown Voltage	BV_{EBO}	5	7	7 max	V
$I_E = 5$ mA, $I_C = 0$					
Collector-to-Emitter Sustaining Voltage					
$V_{BE} = -1.5$ V	$V_{CEV(sus)}$	50	100	160 min	V
$I_C = 0.2$ A, $I_B = 0$	$V_{CEO(sus)}$	40	60	140 min	V
Base-to-Emitter Voltage					
$V_{CE} = 4$ V,					
$I_C = 8$ A ^b	V_{BE}	-	-	2.2 max	V
$I_C = 10$ A ^b	V_{BE}	-	2.2	- max	V
$I_C = 15$ A ^b	V_{BE}	2.7	-	- max	V



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DATA 1
9-65

2N3771, 2N3772, 2N3773

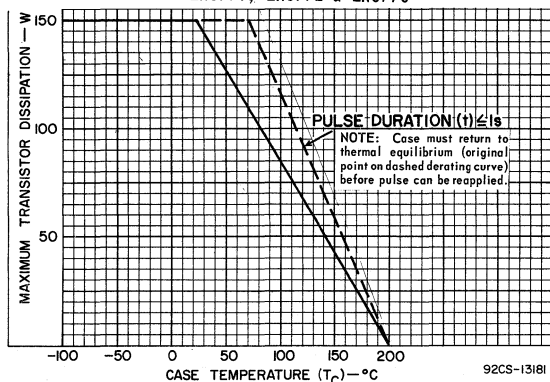
	2N3771	2N3772	2N3773	
Collector-to-Emitter Saturation Voltage				
$I_B = 0.8 \text{ A}, I_C = 8 \text{ A}^b$	$V_{CE(sat)}$	-	-	1.4 max V
$I_B = 1 \text{ A}, I_C = 10 \text{ A}^b$	$V_{CE(sat)}$	-	1.4	- max V
$I_B = 1.5 \text{ A}, I_C = 15 \text{ A}^b$	$V_{CE(sat)}$	2	-	- max V
Collector-Cutoff Current				
$T_C = 25^\circ\text{C}$,				
$V_{CB} = 50 \text{ V}, I_E = 0$	I_{CBO}	2	-	- max mA
$V_{CB} = 100 \text{ V}, I_E = 0$	I_{CBO}	-	5	- max mA
$V_{CB} = 140 \text{ V}, I_E = 0$	I_{CBO}	-	-	2 max mA
$V_{CE} = 50 \text{ V}, V_{BE} = -1.5 \text{ V}$	I_{CEV}	2	-	- max mA
$V_{CE} = 100 \text{ V}, V_{BE} = -1.5 \text{ V}$	I_{CEV}	-	5	- max mA
$V_{CE} = 140 \text{ V}, V_{BE} = -1.5 \text{ V}$	I_{CEV}	-	-	2 max mA
$V_{CE} = 30 \text{ V}, I_B = 0$	I_{CEO}	10	-	- max mA
$V_{CE} = 50 \text{ V}, I_B = 0$	I_{CEO}	-	10	- max mA
$V_{CE} = 120 \text{ V}, I_B = 0$	I_{CEO}	-	-	10 max mA
$T_C = 150^\circ\text{C}$,				
$V_{CB} = 30 \text{ V}, I_E = 0$	I_{CBO}	10	10	10 max mA
$V_{CE} = 30 \text{ V}, V_{BE} = -1.5 \text{ V}$	I_{CEV}	10	10	10 max mA
Emitter-Cutoff Current				
$V_{EB} = 5 \text{ V}, I_C = 0$	I_{EBO}	5	-	- max mA
$V_{EB} = 7 \text{ V}, I_C = 0$	I_{EBO}	-	5	5 max mA
DC Forward-Current Transfer Ratio				
$V_{CE} = 4 \text{ V}$,				
$I_C = 8 \text{ A}^b$	h_{FE}	-	-	15 min
$I_C = 8 \text{ A}^b$	h_{FE}	-	-	60 max
$I_C = 10 \text{ A}^b$	h_{FE}	-	15	- min
$I_C = 10 \text{ A}^b$	h_{FE}	-	60	- max
$I_C = 15 \text{ A}^b$	h_{FE}	15	-	- min
$I_C = 15 \text{ A}^b$	h_{FE}	60	-	- max
Thermal Resistance	θ_{JC}	1.17	1.17	1.17 max $^\circ\text{C/W}$

Junction-to-Case

^a Measured along pin at distances not less than 1/32 inch from seating plane.
^b Pulse duration = 300 μs ; rep. rate = 60 c/s.

Dissipation Derating Curves

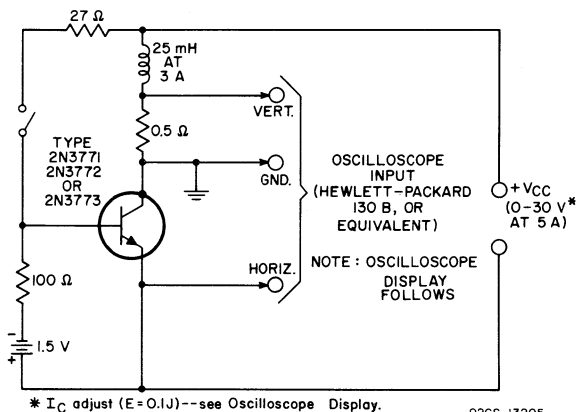
2N3771, 2N3772 & 2N3773



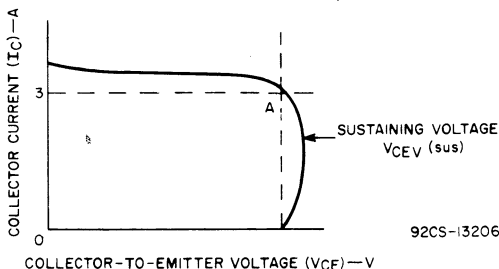
2N3771, 2N3772, 2N3773

SUSTAINING VOLTAGE TEST CIRCUIT $V_{CEV(sus)}$

2N3771, 2N3772, & 2N3773



OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGE $V_{CEV(sus)}$ (See Test Circuit)



Note: The sustaining voltage $V_{CEV(sus)}$ is acceptable when the trace falls to the right and above point "A" for types 2N3771, 2N3772, & 2N3773.



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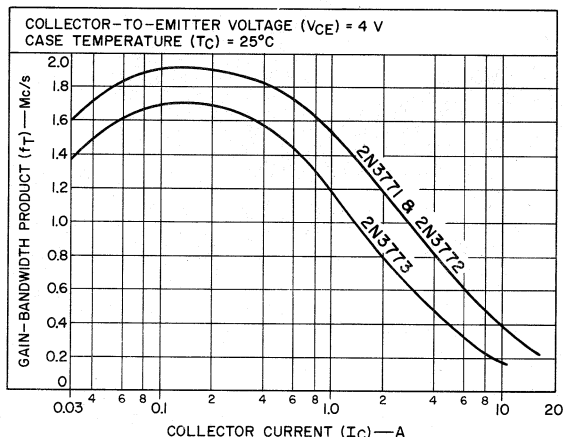
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DATA 2
9-65

2N3771, 2N3772, 2N3773

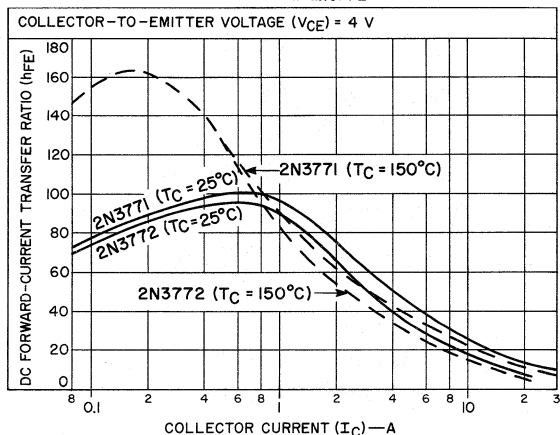
Gain-Bandwidth Product vs. Collector Current

2N3771, 2N3772 & 2N3773



Typical DC-Beta Characteristics

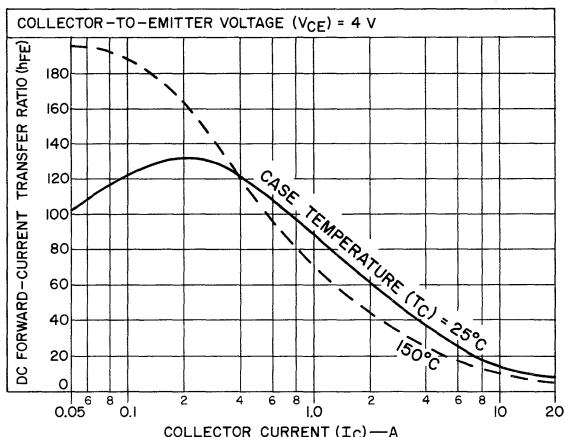
2N3771 & 2N3772



2N3771, 2N3772, 2N3773

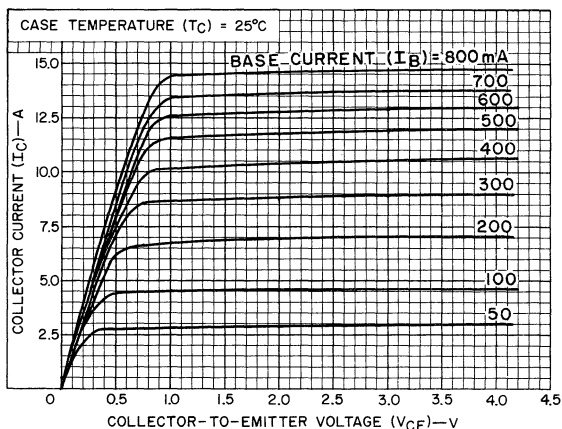
Typical DC-Beta Characteristics

2N3773



Typical Operation Characteristics

2N3771



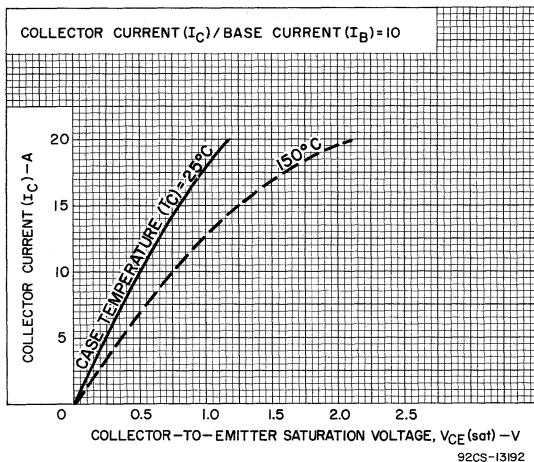
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DATA 3
9-65

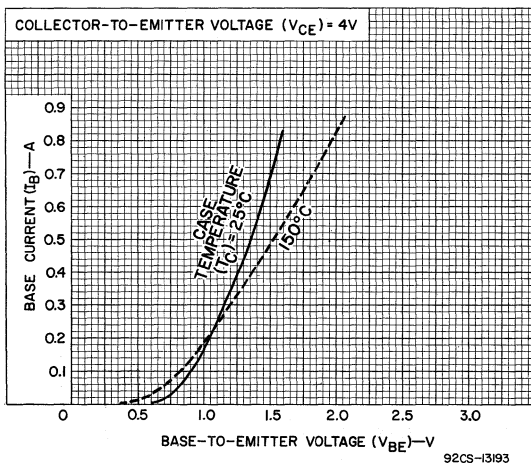
2N3771, 2N3772, 2N3773

Typical Operation Characteristics

2N3771

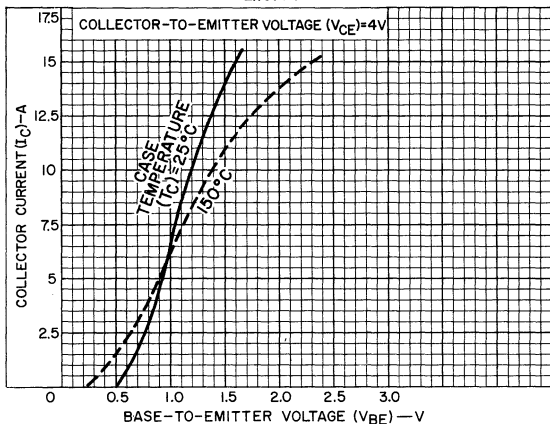


2N3771

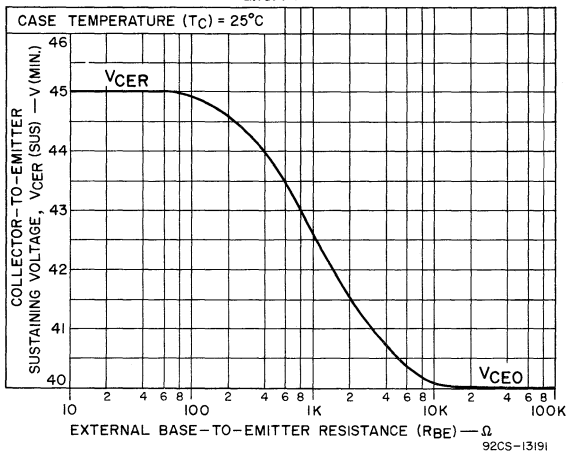


Typical Operation Characteristics

2N3771



2N3771



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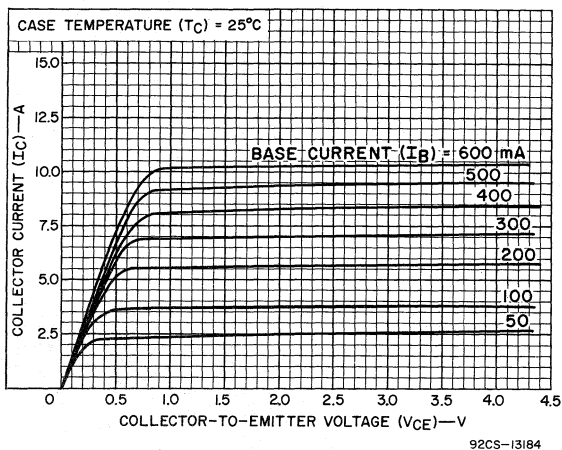
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DATA 4
9-65

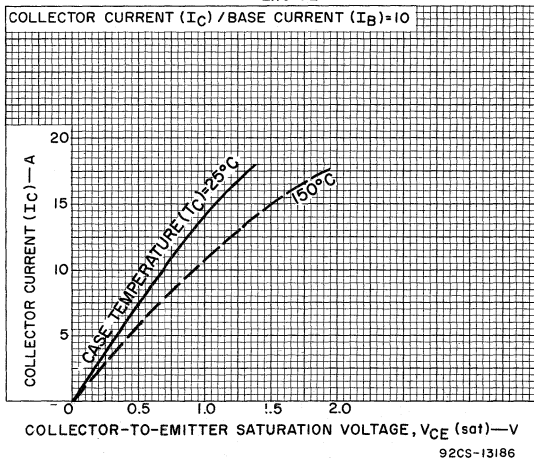
2N3771, 2N3772, 2N3773

Typical Operation Characteristics

2N3772

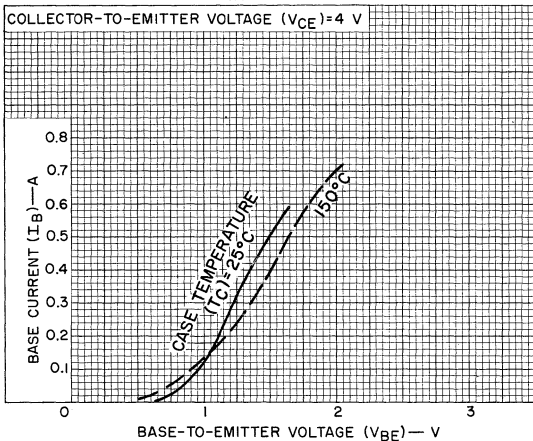


2N3772

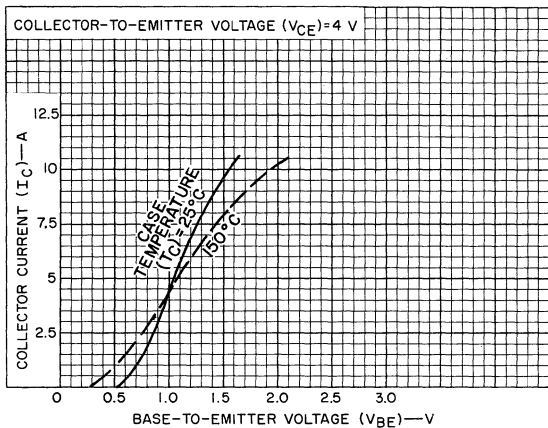


Typical Operation Characteristics

2N3772

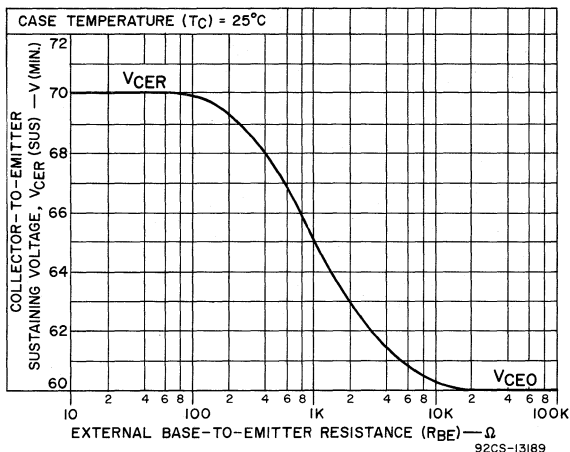


2N3772

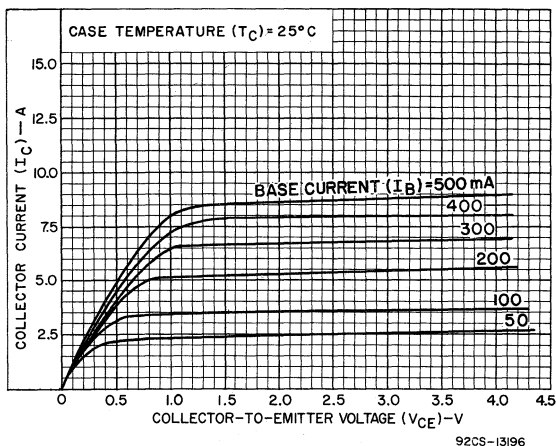


2N3771, 2N3772, 2N3773

2N3772



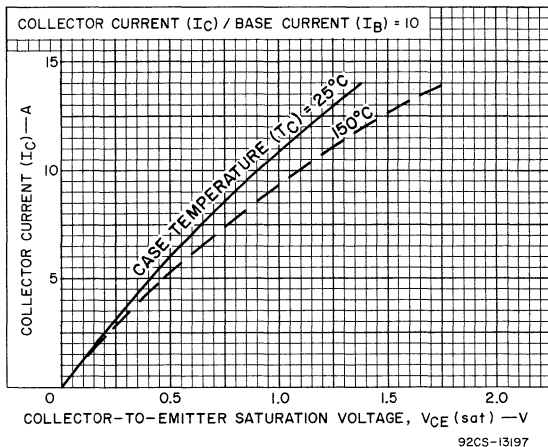
2N3773



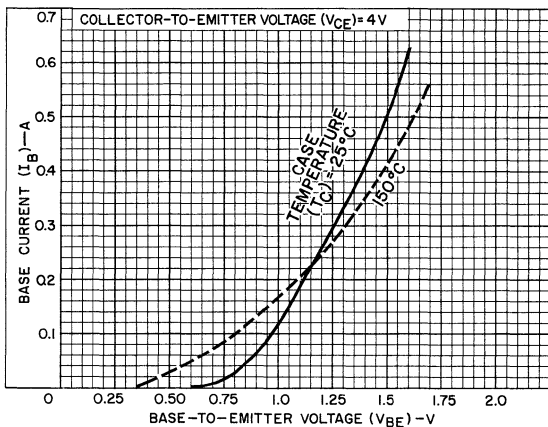
2N3771, 2N3772, 2N3773

Typical Operation Characteristics

2N3773



2N3773



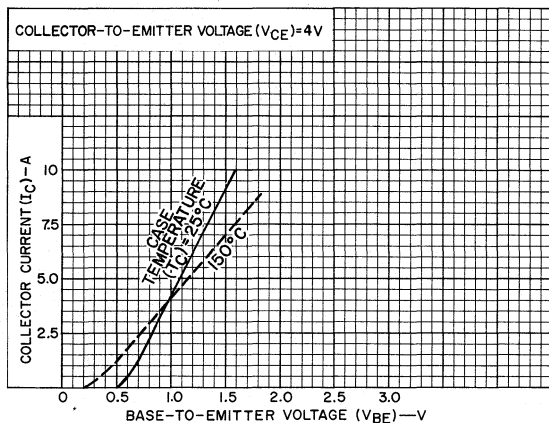
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DATA 6
9-65

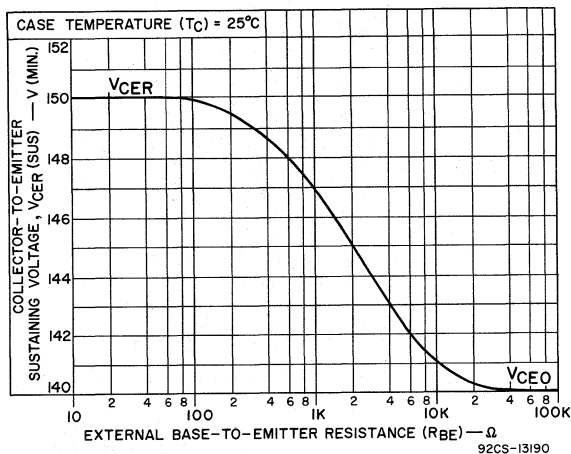
2N3771, 2N3772, 2N3773

Typical Operation Characteristics

2N3773



2N3773



2N3878, 2N3879

Power Transistors

SILICON N-P-N EPITAXIAL TYPES

Typical Applications Include: Low Distortion Power Amplifiers, Oscillators, Switching Regulators, Series Regulators, Converters and Inverters.

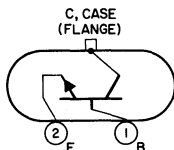
2N3878 is an Amplifier Type for Audio-, Ultrasonic-, and RF Circuits.

2N3879 is a Switching Type for High-Current, High-Speed Switching Circuits.

Dimensions See Outline TO-66 in General Section
Terminal Diagram

BOTTOM VIEW

Pin 1—Base
Pin 2—Emitter



ABSOLUTE-MAXIMUM RATINGS

		<u>2N3878</u>	<u>2N3879</u>	
Collector-to-Base Voltage. . .	V_{CB0}	120	120	V
Collector-to-Emitter Sustaining Voltage				
With $R_{BE} = 50\Omega$	$V_{CER(sus)}$	65	90	V
With base open	$V_{CEO(sus)}$	50	75	V
Emitter-to-Base Voltage. . . .	V_{EB0}	7	7	V
Collector Current.	I_C	7	7	A
Peak Collector Current		10	10	A
Base Current	I_B	5	5	A
Transistor Dissipation				
At case temperatures:				
From -65 to 25°C	P_T	35	35	W
Above 25°C	See Dissipation Derating Curve			
Temperature Range				
Operating (Junction)	$T_{(opr)}$	-65 to 200		$^\circ\text{C}$
Storage.	$T_{(stg)}$	-65 to 200		$^\circ\text{C}$
Pin-Soldering Temperature ^a . .	T_p	255	255	$^\circ\text{C}$
For 10 sec. max				



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DATA 1
10-65

2N3878, 2N3879

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode voltage and electrode-current values for given test conditions are dc at case temperature = 25°C

	2N3878	2N3879	
Collector-to-Emitter Sustaining Voltage^b			
$I_C = 0.2A, R_{BE} = 50\Omega$	$V_{CER(sus)}$	65	90 min V
$I_C = 0.2A, I_B = 0$	$V_{CEO(sus)}$	50	75 min V
Collector-to-Emitter Saturation Voltage			
$I_C = 4A, I_B = 0.5A$	$V_{CE(sat)}$	2	- max V
$I_C = 4A, I_B = 0.4A$	$V_{CE(sat)}$	-	1.2 max V
Base-to-Emitter Voltage.	V_{BE}	2.5	1.8 max V
$V_{CE} = 2V, I_C = 4A$			
Collector-Cutoff Current			
$V_{CE} = 40V, I_B = 0$	I_{CEO}	5	5 max mA
$V_{CE} = 100V, V_{BE} = -1.5V$	I_{CEV}	4	4 max mA
$T_C = 150^\circ C, V_{CE} = 100V,$ $V_{BE} = -1.5V$	I_{CEV}	4	4 max mA
Emitter-Cutoff Current	I_{EBO}	4	2 max mA
$V_{EB} = 4V, I_C = 0$			
DC Forward-Current Transfer Ratio			
$V_{CE} = 5V, I_C = 0.5A$	h_{FE}	50	40 min
$V_{CE} = 5V, I_C = 0.5A$	h_{FE}	200	- max
$V_{CE} = 5V, I_C = 4A$	h_{FE}	20	20 min
$V_{CE} = 5V, I_C = 4A$	h_{FE}	-	80 max
$V_{CE} = 2V, I_C = 4A$	h_{FE}	8	12 min
Small-Signal Forward-Current Transfer Ratio			
$f = 10 \text{ Mc/s}, V_{CE} = 10V,$ $I_C = 0.5A$	h_{fe}	4	4 min
Output Capacitance	C_{ob}	175	175 max pF
$f = 1 \text{ Mc/s}, V_{CB} = 10V, I_E = 0$			
Second-Breakdown Collector Current^c			
Base forward biased $V_{CE} = 40V$	$I_{S/b}$	750	500 min mA
Second-Breakdown Energy^d			
Base reverse biased $R_{BE} = 50\Omega, L = 125 \mu H,$ $V_{BE} = -4V$	$E_{S/b}$	1	1 min mJ
Delay Time			
$V_{CC} = 30V, I_C = 4A,$ $I_{B1} = 0.4A$	t_d	-	40 max ns
Rise Time			
$V_{CC} = 30V, I_C = 4A,$ $I_{B1} = 0.4A$	t_r	-	400 max ns
Storage Time			
$V_{CC} = 30V, I_C = 4A,$ $I_{B2} = -0.4A$	t_s	-	800 max ns
Fall Time			
$V_{CC} = 30V, I_C = 4A, I_{B2} = -0.4A$	t_f	-	400 max ns
Thermal Resistance	θ_{JC}	5	5 max °C/W



- a Measured along pin at a distance not less than $1/32''$ from seating plane.
- b The sustaining voltages **must not** be measured on a curve tracer. They should be measured by means of the accompanying *Circuit Used to Measure Sustaining Voltages $V_{CE0}(sus)$ & $V_{CEB}(sus)$* .
- c Second-Breakdown Collector Current ($I_{S/b}$) is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-to-base junction forward biased for transistor operation in the active region. See *Operating Considerations* for safe-operating region for second breakdown.
- d Second-Breakdown Energy ($E_{S/b}$) is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2 LI^2$, where L is a series load or leakage inductance and I is the peak collector current.

OPERATING CONSIDERATIONS

Second Breakdown ($I_{S/b}$) is a potentially destructive phenomenon which occurs in bipolar transistors (n-p-n and p-n-p) and results from the transistor absorbing a critical amount of energy. The initiation of second breakdown is characterized by an abrupt decrease in collector-to-emitter voltage, V_{CE} , with a small positive dynamic resistance in the second-breakdown region. In general, transistors with higher-frequency response or faster switching speed characteristics, and higher collector-to-emitter voltage-breakdown capabilities are more susceptible to failure from second breakdown. The critical energy required to produce second breakdown is a variable which depends on operating conditions.

With the emitter-base junction forward biased for transistor operation in the active region, the severity of second breakdown depends on the operating collector-to-emitter voltage, duration of the applied voltage, and transistor temperature. The *Dissipation Derating Curves* are applicable to the 2N3878 and 2N3879 at different temperatures. The portion of the curves with slope equal to -1 on these logarithmic plots indicates the regions where the device is thermally limited (i.e., maximum allowable power dissipation is constant at 35 watts). That portion where the slope is approximately -2.5 shows the region where the device is second breakdown limited, and applies for one-second pulse duration (essentially equal to DC operation). For shorter pulses, the transistor's second breakdown capability improves.

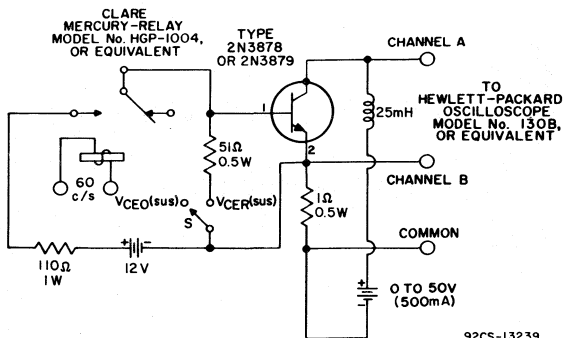
The energy required to induce second breakdown when the transistor is turned off depends on the current during the on condition, the emitter-to-base voltage and resistance when the transistor is turned off, and the amount of inductance in series with the collector. It is much lower than that required in the forward-bias mode. The accompanying Reverse-Bias, Second-Breakdown Characteristics curves are recommended when designing circuits having inductive loads (such as solenoid- or relay-control circuits, magnetic-deflection circuits, and switching regulators) without protective zener diodes across the collector-to-emitter terminals. These curves can also be used when designing circuits where some leakage inductance is present (such as in inverters, converters, and transformer-coupled power amplifiers).



2N3878, 2N3879

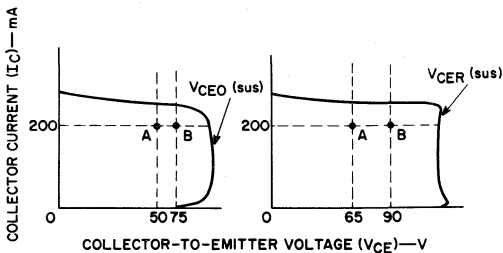
SUSTAINING VOLTAGE TEST CIRCUIT

$V_{CEO(sus)}$ & $V_{CER(sus)}$



92CS-13239

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGES

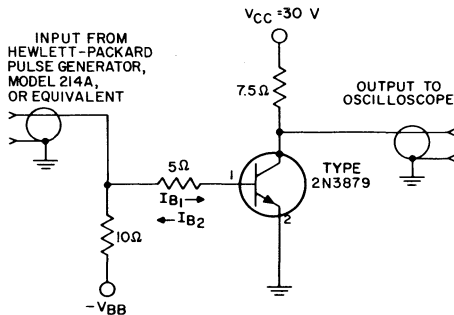


92CS-13240

Note: The sustaining voltages $V_{CEO(sus)}$ and $V_{CER(sus)}$ are acceptable when the traces fall to the right and above points "A" and "B" for types 2N3878 and 2N3879, respectively.



CIRCUIT USED TO MEASURE SWITCHING TIMES 2N3879



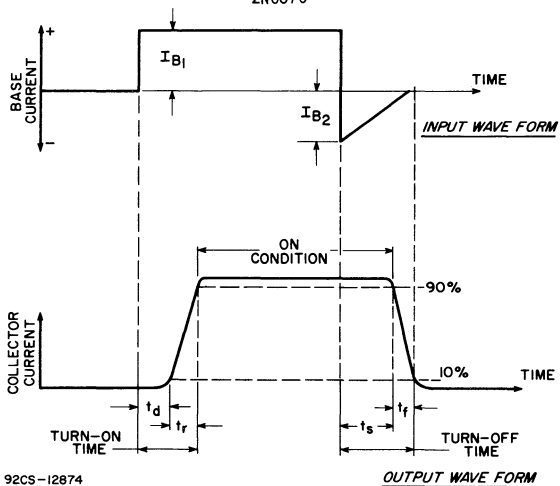
92CS-13238

Input Pulse:

Pulse rep. rate = 1,000 pulses/s

Pulse width = 20 μs

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SWITCHING TIMES 2N3879



92CS-12874



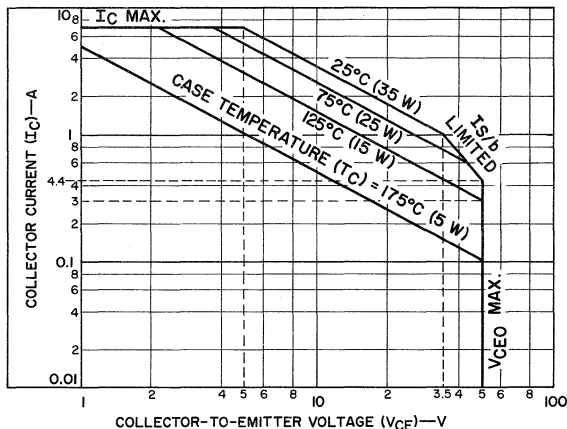
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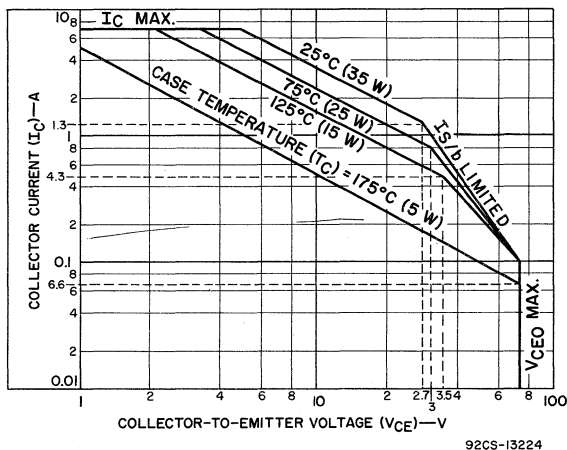
DATA 3
10-65

Dissipation Derating Curves

2N3878

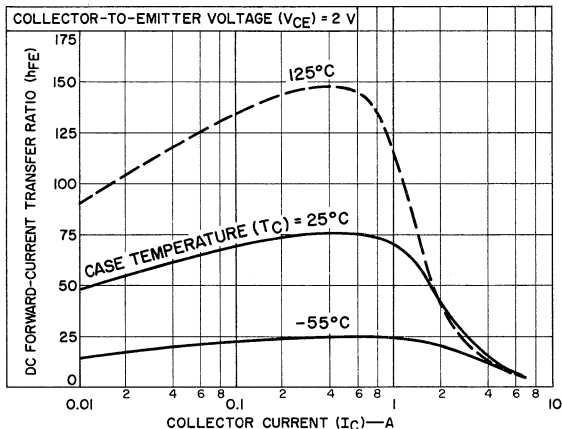


2N3879

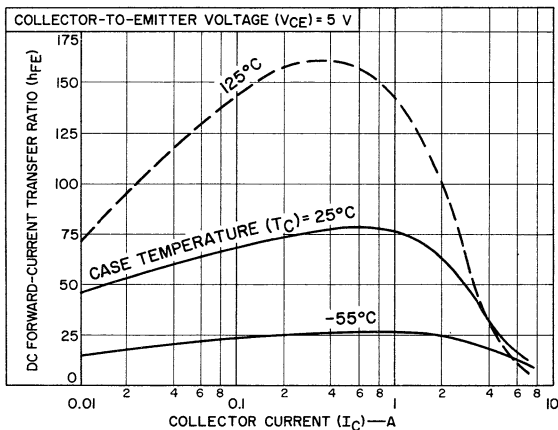


Typical DC Forward-Current Transfer-Ratio (h_{FE}) Characteristics

2N3878 & 2N3879



2N3878 & 2N3879



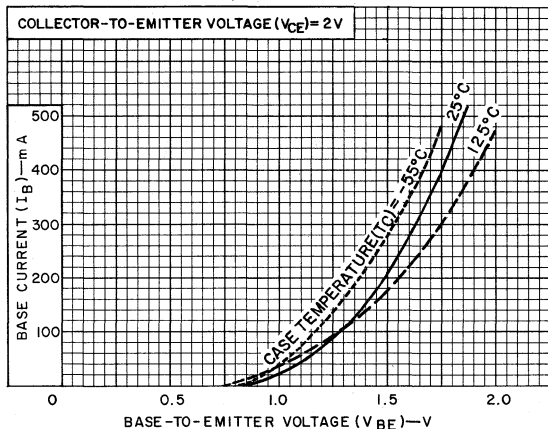
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DATA 4
10-65

2N3878, 2N3879

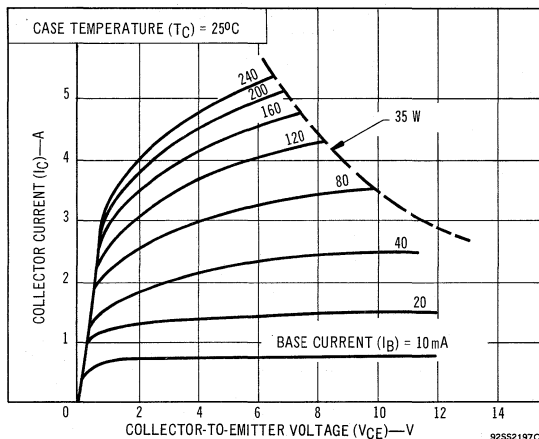
Typical Input Characteristics

2N3878 & 2N3879



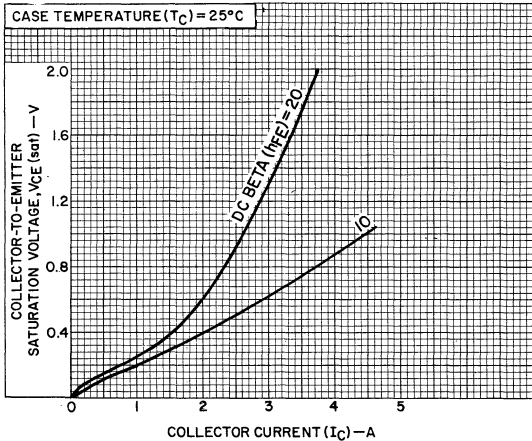
Typical Collector Characteristics

2N3878 & 2N3879



Collector-to-Emitter Saturation Voltage vs. Collector Current

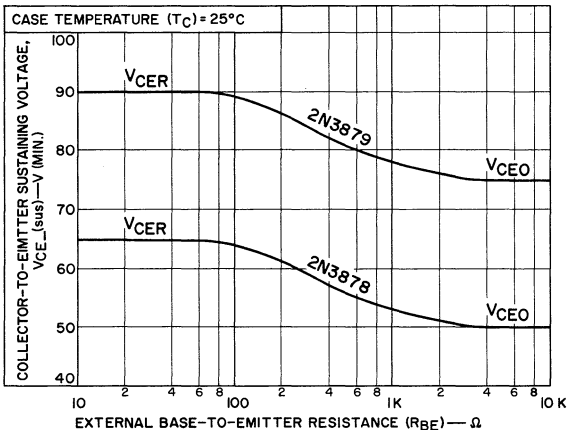
2N3879



92CS-13236

Sustaining Voltage vs. Base-to-Emitter Resistance

2N3878 & 2N3879



92CS-13229



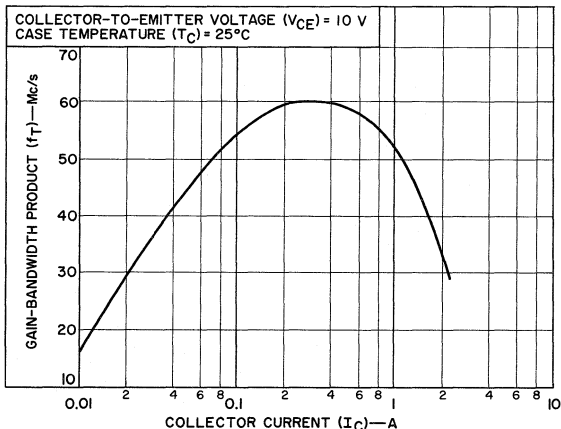
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DATA 5
10-65

2N3878, 2N3879

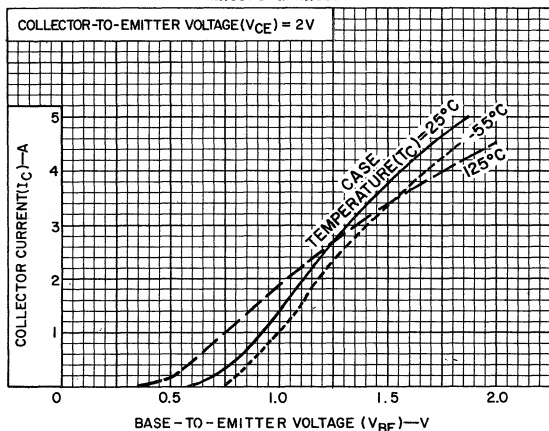
Typical Gain-Bandwidth Product vs. Collector Current

2N3878 & 2N3879



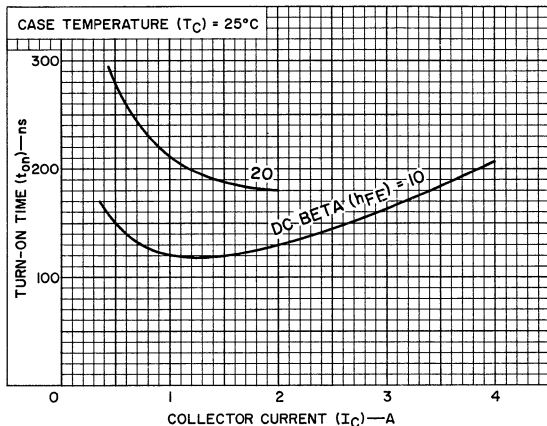
Typical Transfer Characteristics

2N3878 & 2N3879



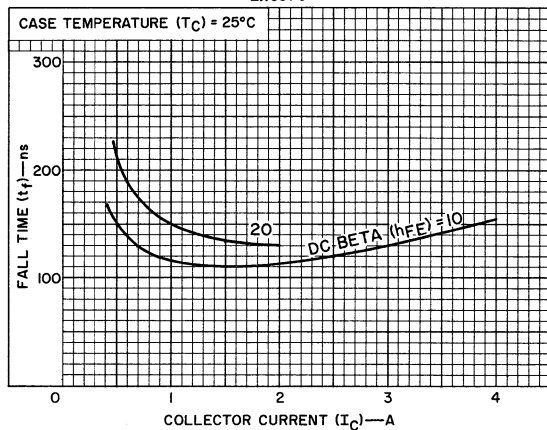
Turn-On Time vs. Collector Current

2N3879



Fall Time vs. Collector Current

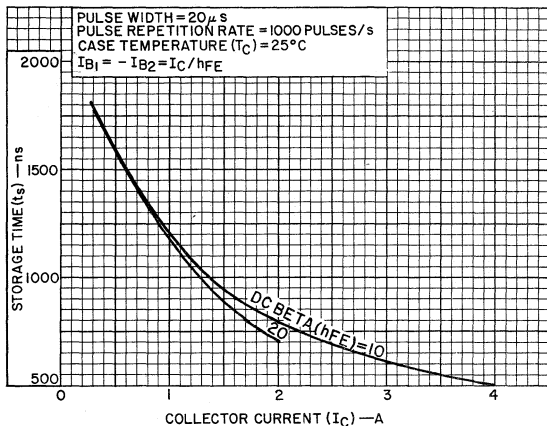
2N3879



2N3878, 2N3879

Storage Time vs. Collector Current

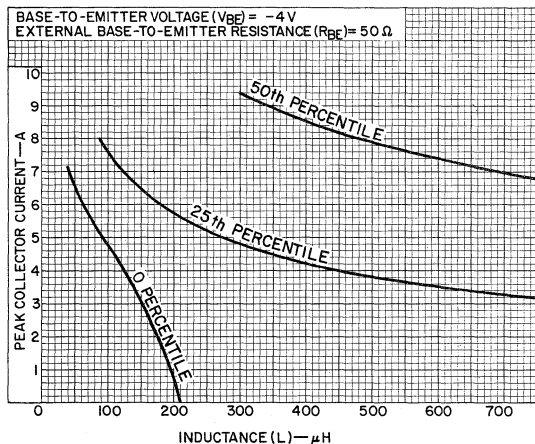
2N3879



92CS-13237

Reverse-Bias, Second-Breakdown Characteristics

2N3878 & 2N3879

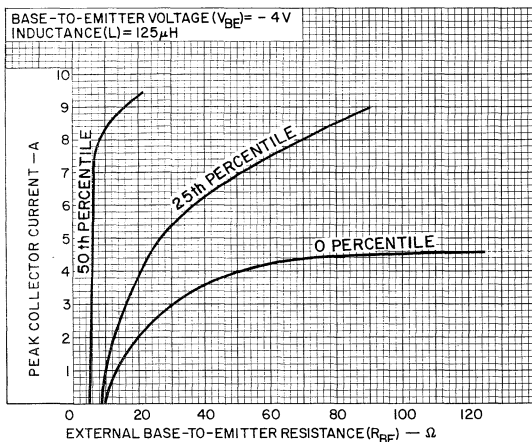


92CS-13230



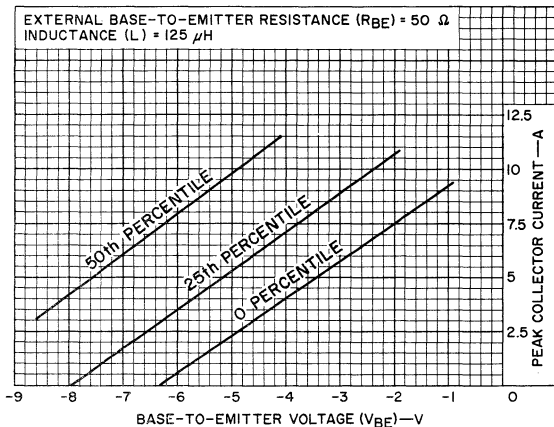
Reverse-Bias, Second-Breakdown Characteristics

2N3878 & 2N3879



92CS-13233

2N3878 & 2N3879



92CS-13232



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DATA 7
10-65

2N3896 to 2N3899

Silicon Controlled Rectifiers

Also known as reverse-blocking triode thyristors

N-P-N-P ALL-DIFFUSED, 3-JUNCTION TYPES

2N3896-For Low-Voltage Power Supplies

2N3897-For 120-Volt Line Operation

2N3898-For 240-Volt Line Operation

2N3899-For High-Voltage Power Supplies

The 2N3896 through 2N3899 are the same as the 2N3870 through 2N3873 respectively, except for the following items:

STUD MOUNTING TYPES

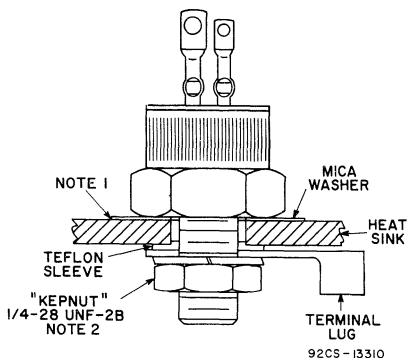
For Use in Power-Control and Power Switching Applications

MECHANICAL

Dimensions See accompanying *Dimensional Outline*

SUGGESTED MOUNTING ARRANGEMENT

For Insulating Types 2N3896-2N3899 From Heat Sink. Components Shown (Except Heat Sink) Are Furnished With Each Device



Note 1: Dow Corning 340 silicon heat-sink compound, or equivalent.

Note 2: The recommended torque is 26 to 36 inch-pounds applied to a 1/4-28 UHF-2B hex nut assembled on thread. The applied torque during installation should not exceed 50 inch-pounds.



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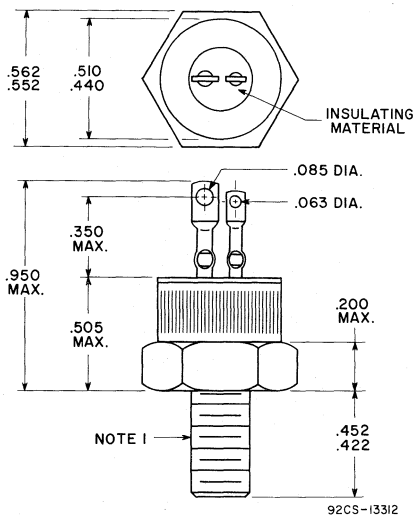
DATA
12-65

2N3896 to 2N3899

CASE-TO-HEAT SINK THERMAL RESISTANCES

2N3896 through 2N3899	Directly mounted on heat sink with or without the use of heat sink compound.	0.6° C/W
	Mounted on heat sink with a 0.004" to 0.006" thick mica insulating washer used between unit and heat sink.	
	Without heat sink compound	2.5° C/W
	With heat sink compound	1.5° C/W

DIMENSIONAL OUTLINE



Dimensions in Inches

Note 1: 1/4-28 UNF-2A. Maximum pitch dia. of plated threads shall be basic pitch dia. 0.2268", minimum pitch dia. 0.2225". Ref. (screw thread standards for federal services 1957) hand-book H28 1957 P1.

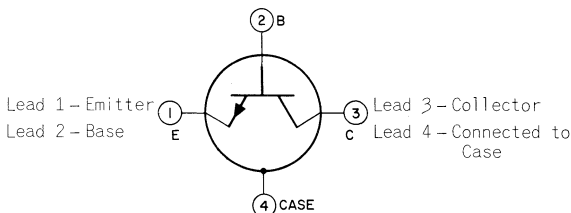
Transistors

SILICON N-P-N EPITAXIAL-PLANAR TYPES

For General-Purpose RF Amplifier Applications
at Frequencies up to 450 Mc/s

Dimensions See accompanying Dimensional Outline

TERMINAL DIAGRAM (Bottom View)



ABSOLUTE-MAXIMUM RATINGS

		2N3932	2N3933	
Collector-to-Base Voltage.	V_{CB0}	30	40	V
Collector-to-Emitter Voltage	V_{CE0}	20	30	V
Emitter-to-Base Voltage.	V_{EB0}	2.5	2.5	V
Collector Current.	I_C	Limited by dissipation		
Transistor Dissipation				
At free-air temperatures:				
From -65° to 25° C	P_T	175	175	mW
Above 25° C.	Derate	linearly 1.17 mW/ $^{\circ}$ C		
Temperature Range (Junction)				
Operating.	$T(\text{opr})$	-65 to 175		$^{\circ}$ C
Storage.	$T(\text{stg})$	-65 to 175		$^{\circ}$ C
Lead-Soldering Temperature ^a		230	230	$^{\circ}$ C
For 10 s max				

ELECTRICAL CHARACTERISTICS

Electrode-voltage and electrode-current values for given test conditions are dc at free-air temperature = 25° C

		2N3932	2N3933	
Collector-to-Base Breakdown				
Voltage	BV_{CB0}	30	40	min V
$I_C = 0.001$ mA, $I_E = 0$				
Collector-to-Emitter Breakdown				
Voltage	BV_{CE0}	20	30	min V
$I_C = 1$ mA				
Emitter-to-Base Breakdown				
Voltage	BV_{EB0}	2.5	2.5	min V
$I_E = 0.001$ mA, $I_C = 0$				
Collector-Cutoff Current	I_{CB0}	0.01	0.01	max μ A
$V_{CB} = 15$ V, $I_E = 0$				



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DATA 1
12-65

2N3932, 2N3933

2N3932 2N3933

DC Forward-Current Transfer Ratio

$V_{CE} = 8 \text{ V}$, $I_C = 2 \text{ mA}$

$V_{CE} = 8 \text{ V}$, $I_C = 2 \text{ mA}$

h_{FE}	40	60	min
h_{FE}	150	200	max

Small-Signal Forward-Current Transfer Ratio^b

$f = 100 \text{ Mc/s}$, $V_{CE} = 8 \text{ V}$, $I_C = 2 \text{ mA}$

$f = 100 \text{ Mc/s}$, $V_{CE} = 8 \text{ V}$, $I_C = 2 \text{ mA}$

$ h_{fe} $	7.5	7.5	min
$ h_{fe} $	16	16	max
C_{ob}	0.55	0.55	max pF

Collector-to-Base Capacitance^c

$f = 0.1 \text{ to } 1 \text{ Mc/s}$, $V_{CB} = 8 \text{ V}$, $I_E = 0$

Collector-to-Base Time Constant

$f = 31.9 \text{ Mc/s}$, $V_{CB} = 8 \text{ V}$,

$I_E = 2 \text{ mA}$

$f = 31.9 \text{ Mc/s}$, $V_{CB} = 8 \text{ V}$,

$I_E = 2 \text{ mA}$

$r_b' C_c$	1	1	min ps
$r_b' C_c$	8	6	max ps

Small-Signal Power Gain

UNNEUTRALIZED AMPLIFIER CIRCUIT^e

$f = 200 \text{ Mc/s}$, $V_{CB} = 8 \text{ V}$,

$I_C = 2 \text{ mA}$

$f = 200 \text{ Mc/s}$, $V_{CB} = 8 \text{ V}$,

$I_C = 2 \text{ mA}$

G_{pe}	11.5	14	min dB
G_{pe}	17	18	max dB

Noise Figure^{e, f}

$f = 60 \text{ Mc/s}$, $R(in)^d = 400 \Omega$,

$V_{CE} = 6 \text{ V}$, $I_C = 1 \text{ mA}$

$f = 60 \text{ Mc/s}$, $R(in)^d = 400 \Omega$,

$V_{CE} = 6 \text{ V}$, $I_C = 1 \text{ mA}$

$f = 200 \text{ Mc/s}$, $R(in)^d = 200 \Omega$,

$V_{CE} = 8 \text{ V}$, $I_C = 2 \text{ mA}$

$f = 450 \text{ Mc/s}$, $R(in)^d = 100 \Omega$,

$V_{CE} = 6 \text{ V}$, $I_C = 1.5 \text{ mA}$

NF	2.5	-	typ dB
NF	-	3	max dB
NF	4.5	4	max dB
NF	5	5	typ dB

^a Measured along lead at distance not less than 1/16 inch from seating surface.

^b Lead No. 4 (case) grounded.

^c Three-terminal measurement; lead No. 1 (emitter) and lead No. 4 (case) connected to guard terminal on capacitance test set.

^d Source resistance seen by transistor.

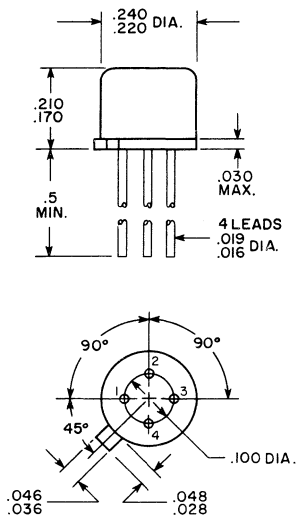
^e See accompanying Power-Gain & Noise-Figure Test Circuit—Unneutralized Amplifier, 200 Mc/s.

^f See accompanying Block Diagram of Noise-Figure Test Circuit.



2N3932, 2N3933

DIMENSIONAL OUTLINE



92CS-12916

DIMENSIONS IN INCHES

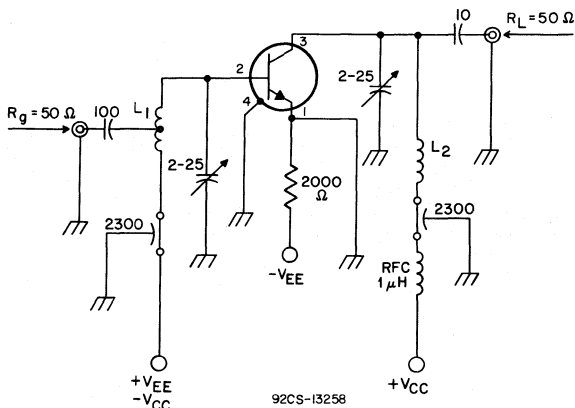


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DATA 2
12-65

POWER-GAIN & NOISE-FIGURE TEST CIRCUIT

Unneutralized Amplifier, 200 Mc/s



All Capacitance Values in Picofarads

L_1 = 1/2 turn No.14 FORMVAR* wire; center-tapped; total wire length = 2 inches.

L_2 = 1/2 turn No.14 FORMVAR wire; total wire length = 1-1/2 inches

Q = Type 2N3932, 2N3933

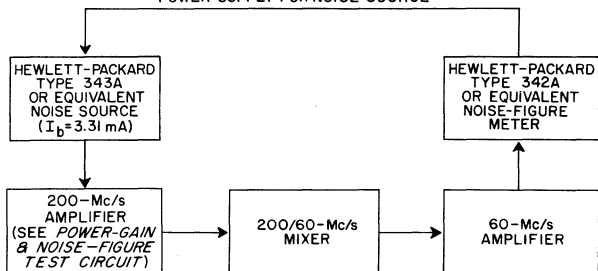
ch = Chassis Ground

Transistor Terminating Resistances (R_g and R_L) = 200 ohms

* Registered Trade Mark of Shawinidan Products Corp.

BLOCK DIAGRAM OF NOISE-FIGURE TEST CIRCUIT

POWER SUPPLY FOR NOISE SOURCE

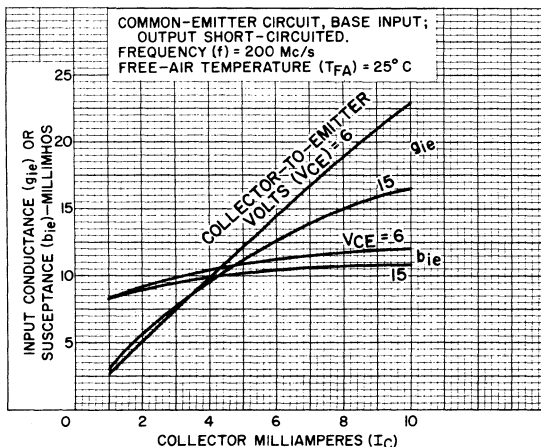


92CS-13259RI

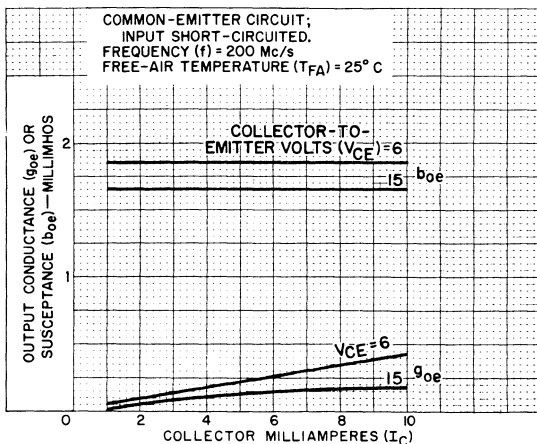


Typical Two-Port Admittance "Y" Parameters

INPUT ADMITTANCE (y_{ie})

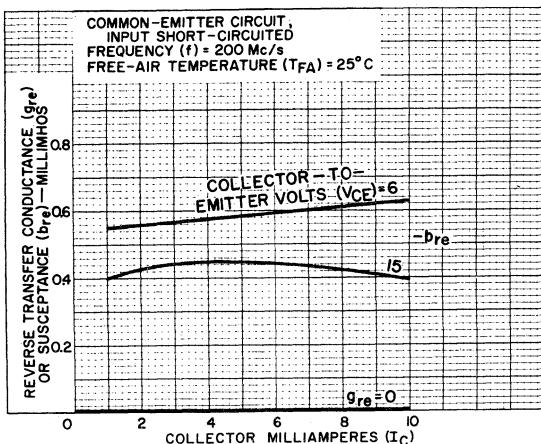
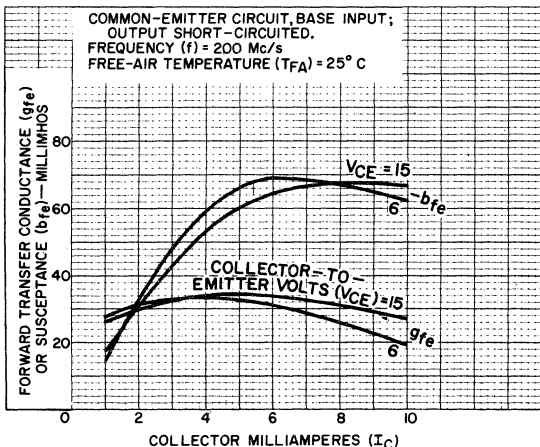


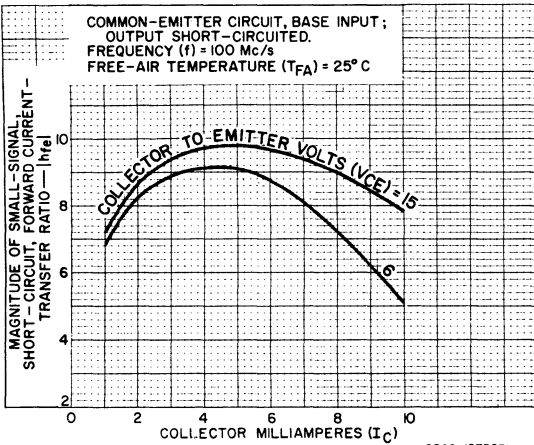
OUTPUT ADMITTANCE (y_{oe})

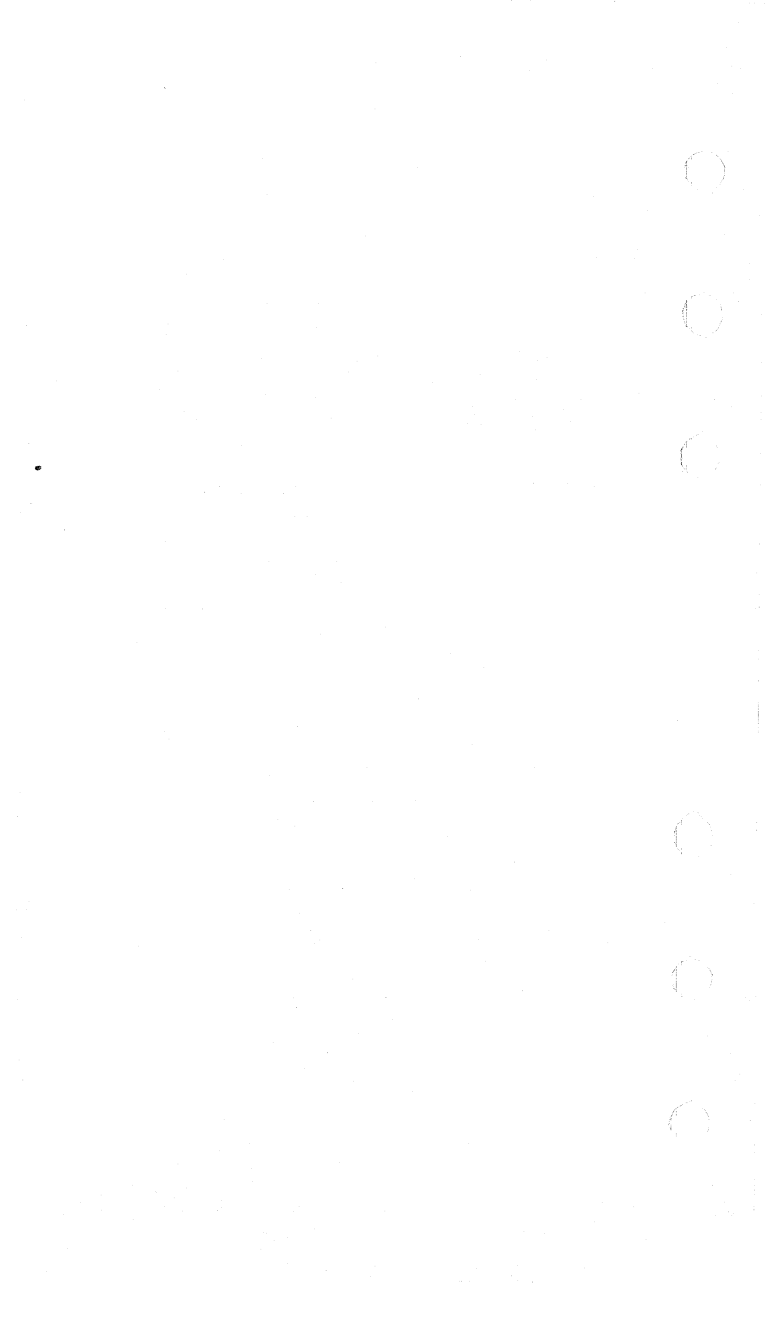


Typical Two-Port Admittance "Y" Parameters

FORWARD TRANSADMITTANCE (y_{fe})



Typical Small-Signal Beta (h_{fe}) Characteristics



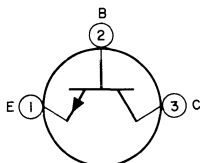
Transistor

SILICON N-P-N "OVERLAY" EPITAXIAL-PLANAR TYPE

Designed to Provide High Power as a Frequency-Multiplier into the UHF or L-Band Range in Military and Industrial Communications Equipment

Dimensions. See Outline TO-60 in General Section
Terminal Diagram BOTTOM VIEW

Pin 1—Emitter
Pin 2—Base



Pin 3—Collector

ABSOLUTE-MAXIMUM RATINGS

Collector-to-Base Voltage	V_{CB0}	65	V
Collector-to-Emitter Voltage			
With $V_{BE} = -1.5$ V	V_{CEV}	65	V
With base open.	V_{CEO}	40	V
Emitter-to-Base Voltage	V_{EB0}	4	V
Collector Current	I_C	1.5	A
Transistor Dissipation			
At case temperatures:			
From -65° to 25°C	P_T	11.6	W
Above 25°C	Derate linearly to 0 watts at 200°C		
Temperature Range			
Operating (Junction).	$T(\text{opr})$	-65 to 200	$^{\circ}\text{C}$
Storage	$T(\text{stg})$	-65 to 200	$^{\circ}\text{C}$
Pin-Soldering Temperature ^a		230	$^{\circ}\text{C}$
For 10 s max			

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode voltage and electrode-current values for given test conditions are dc at case temperature = 25°C

		Min	Typ	Max	
Collector-to-Base					
Breakdown Voltage.	BV_{CB0}	65	-	-	V
$I_C = 0.1$ mA, $I_E = 0$					
Collector-to-Emitter					
Breakdown Voltage					
I_C (Pulsed) = 0 to 200 mA ^b ,					
$V_{BE} = -1.5$ V	BV_{CEV}	65°C	-	-	V
I_C (Pulsed) = 0 to 200 mA ^b ,					
$I_B = 0$	BV_{CEO}	40°C	-	-	V
Emitter-to-Base					
Breakdown Voltage.	BV_{EB0}	4	-	-	V
$I_E = 0.1$ mA, $I_C = 0$					

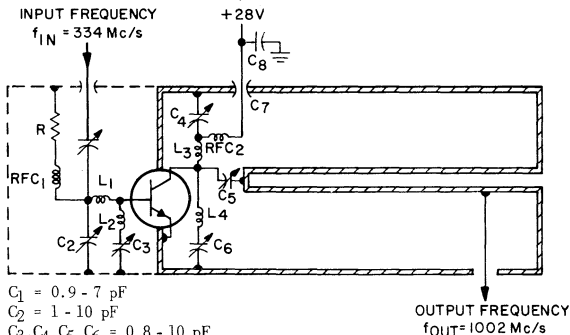


Min Typ Max

Collector-to-EmitterSaturation Voltage $V_{CE(sat)}$ - - 1 V $I_C = 0.5$ A, $I_B = 100$ mACollector-Cutoff Current. I_{CE0} - - 0.1 mA $V_{CE} = 30$ V, $I_B = 0$ Base-Spreading Resistance $r_{bb'}$ - 10 - Ω $f = 400$ Mc/s, $V_{CE} = 28$ V, $I_C = 250$ mAOutput Capacitance. C_{obo} - - 10 pF $f = 1$ Mc/s, $V_{CB} = 30$ V, $I_E = 0$ Gain-Bandwidth Product. f_T - 500 - Mc/s $V_{CE} = 28$ V, $I_C = 150$ mA**RF Power Output^d** $V_{CE} = 28$ V, $P_i = 1$ W, $f = 334$ Mc/sTripler at 1002 Mc/s P_{oe} 2.5^e - - W $V_{CE} = 28$ V, $P_i = 1$ W, $f = 400$ Mc/sDoubler at 800 Mc/s. P_{oe} - 3^f - W**Collector-to-Base**Cutoff Frequency^g. - 25 - Gc/s $V_{CE} = 28$ V, $I_C = 0$ ^a Measured along pin at distances not less than 1/32" from ceramic wafer.^b Pulsed through an inductor (25 mH); duty factor = 0.5.^c Measured at a current where the breakdown voltage is a minimum.^d See accompanying *Power Output Measurement Circuits* for Tripler and Doubler.^e For conditions given, minimum efficiency = 25 per cent.^f For conditions given, minimum efficiency = 35 per cent.^g Cutoff frequency is determined from Q measurement at 210 Mc/s. The collector-to-base junction cutoff frequency for this transistor is determined by the equation, Cutoff Frequency = $Q \times 210$ Mc/s.

POWER OUTPUT MEASUREMENT CIRCUITS

Tripler Circuit



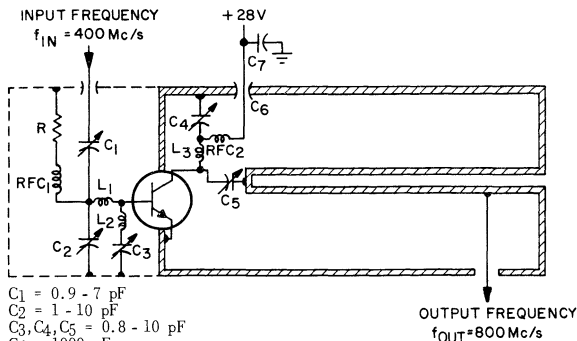
92CS-13442

- $C_1 = 0.9 - 7 \text{ pF}$
 $C_2 = 1 - 10 \text{ pF}$
 $C_3, C_4, C_5, C_6 = 0.8 - 10 \text{ pF}$
 $C_7 = 1000 \text{ pF}$
 $C_8 = 0.2 \text{ }\mu\text{F}$
 $\text{RFC}_1 = 0.22 \text{ }\mu\text{H}$
 $\text{RFC}_2 = 0.33 \text{ ohms, W.W. Resistor}$
 $L_1 = 2 \text{ turns, } 3/8'' \text{ diameter, No.16 wire}$
 $L_2 = 1/16'' \text{ width copper strip, } 3/8'' \text{ long}$
 $L_3 = 2 \text{ turns, } 3/8'' \text{ diameter, No.18 wire}$

$L_4 = 1-1/2 \text{ turns, } 3/8'' \text{ diameter, } 1/16 \text{ copper strip}$
 $R = 2.7 \text{ ohms}$

Output Cavity = $1-1/4'' \times 1-1/4'' \times 2-1/4''$
 Center Conductor = $1/4'' \text{ OD tube}$
 Output direct couple = $1'' \text{ from shorted end}$

Doubler Circuit



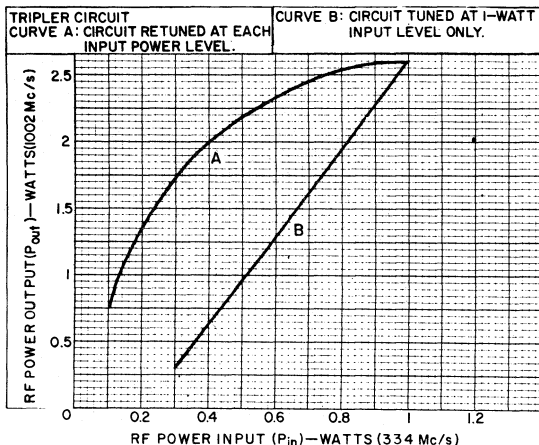
92CS-13443

- $C_1 = 0.9 - 7 \text{ pF}$
 $C_2 = 1 - 10 \text{ pF}$
 $C_3, C_4, C_5 = 0.8 - 10 \text{ pF}$
 $C_6 = 1000 \text{ pF}$
 $C_7 = 0.2 \text{ }\mu\text{F}$
 $\text{RFC}_1 = 0.22 \text{ }\mu\text{H}$
 $\text{RFC}_2 = 0.33 \text{ ohms, W.W. Resistor}$
 $R = 2.7 \text{ ohms}$
 $L_1 = 1 \text{ turn, } 3/8'' \text{ diameter, No.16 wire}$
 $L_2 = 1/16'' \text{ width copper strip, } 3/8'' \text{ long}$

$L_3 = 2 \text{ turns, } 3/8'' \text{ diameter, No.18 wire}$
 Output Cavity = $1-1/4'' \times 1-1/4'' \times 2-1/4''$
 Center Conductor = $1/4'' \text{ OD tube}$
 Output direct couple = $1'' \text{ from shorted end}$

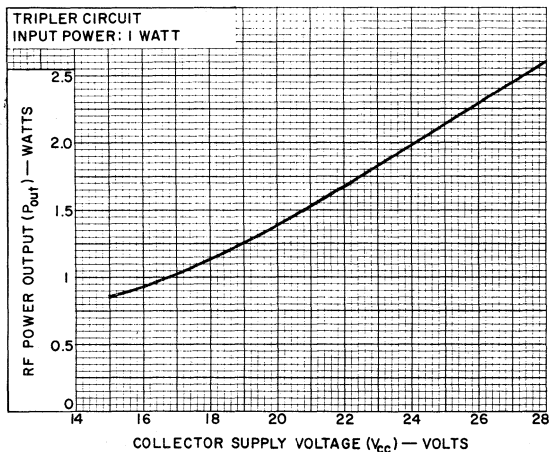


Power Output vs. Power Input



92CS-13444

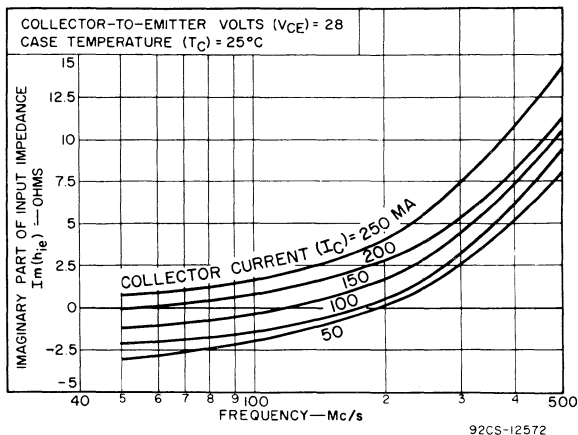
Power Output vs. Collector Supply Voltage



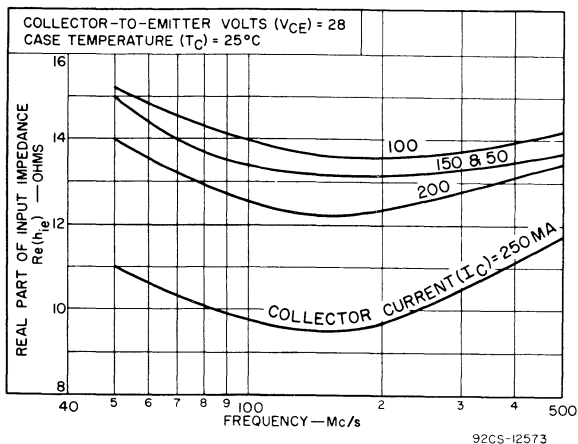
92CS-13445



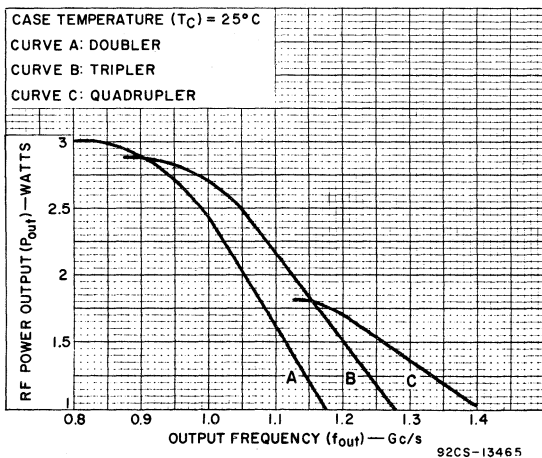
Series Input Reactance vs. Frequency



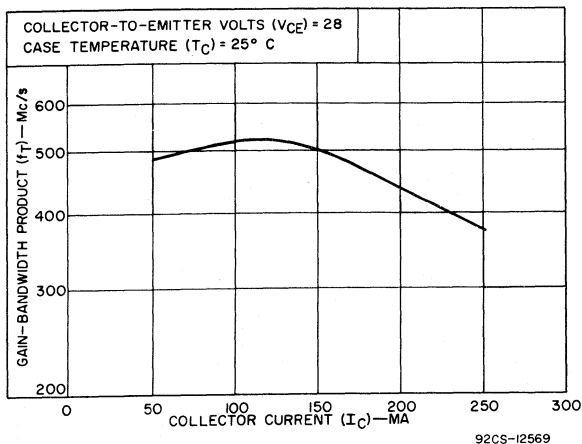
Series Input Resistance vs. Frequency



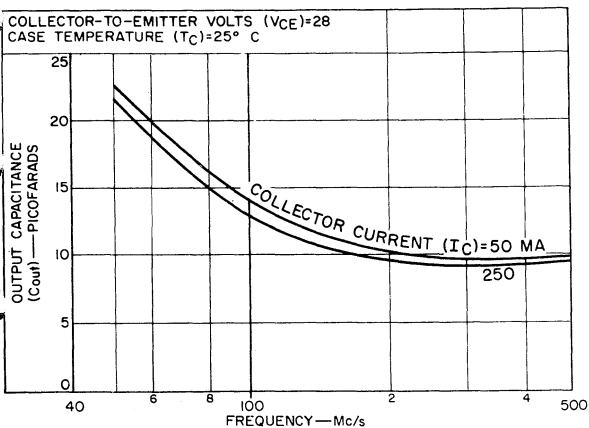
Power Output vs. Output Frequency



Gain-Bandwidth Product vs. Collector Current

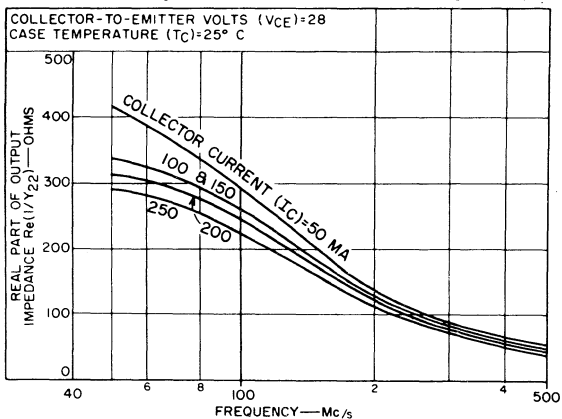


Parallel Output Capacitance vs. Frequency



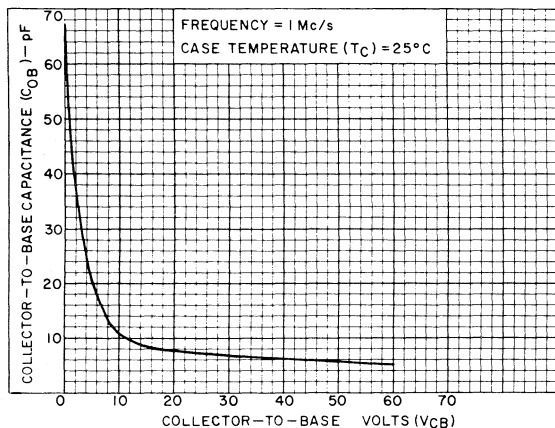
92CS-12576

Parallel Output Resistance vs. Frequency



92CS-12574



Collector-to-Base Capacitance vs.
Collector-to-Base Voltage

92CS-13441



2N4036, 2N4037

Power Transistors

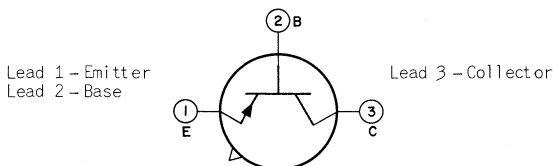
SILICON P-N-P DOUBLE-DIFFUSED EPITAXIAL-PLANAR TYPES

For a Wide Variety of Small Signal, Medium-Power General-Purpose Military, Industrial, and Commercial Applications. Types 2N4036 and 2N4037 are P-N-P Complements of Types 2N2102 and 2N3053 Respectively. Type 2N4036 is Recommended for Use in High-Speed Saturated Switching Applications.

MECHANICAL

Dimensions See Outline TO-5 in General Section

TERMINAL DIAGRAM (Bottom View)



ABSOLUTE-MAXIMUM RATINGS

		2N4036	2N4037	
Collector-to-Base Voltage. . .	V_{CB0}	-90	-60	V
Collector-to-Emitter Sustaining Voltage				
$V_{BE} = 1.5$ V.	$V_{CEV(sus)}$	-85	-60	V
$R_{BE} \leq 200 \Omega$	$V_{CER(sus)}$	-85	-60	V
Base open.	$V_{CEO(sus)}$	-65	-40	V
Emitter-to-Base Voltage. . . .	V_{EBO}	-7	-7	V
Collector Current.	I_C	-1	-1	A
Base Current.	I_B	-0.5	-0.5	A
Transistor Dissipation				
At case temperatures:				
From -65 to 25 °C.	P_T	7	7	W
Above 25 °C.	Derate linearly to 0 W at 200 °C			
At free-air temperatures:				
From -65 to 25 °C.	P_T	1	1	W
Above 25 °C.	Derate linearly to 0 W at 200 °C			
For pulse operation.	See Maximum Operating Areas			
Temperature Range				
Operating (Junction)	$T(opr)$	-65 to 200		°C
Storage.	$T(stg)$	-65 to 200		°C
Lead-Soldering Temperature ^a . .		230	230	°C
For 10 s max				



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DATA 1
4-66

2N4036, 2N4037

Electrode-voltage and electrode-current values for given test conditions are dc at case temperature = 25 °C.

	2N4036	2N4037	
Collector-to-Base Breakdown Voltage . BV_{CBO}	-90	-60 min	V
$I_C = -0.1$ mA, $I_E = 0$			
Emitter-to-Base Breakdown Voltage . . BV_{EBO}	-7	-7 min	V
$I_E = -0.1$ mA, $I_C = 0$			
Collector-to-Emitter Sustaining Voltage			
$V_{BE} = 1.5$ V, $I_C = -100$ mA $V_{CEV(sus)}$	-85 ^b	-60 ^b min	V
$R_{BE} \leq 200 \Omega$, $I_C = -100$ mA $V_{CER(sus)}$	-85 ^b	-60 ^b min	V
$I_C = -100$ mA, $I_B = 0$ $V_{CEO(sus)}$	-65 ^b	-40 ^b min	V
Collector-to-Emitter Voltage. $V_{CE(sat)}$	-0.65	-1.4 max	V
$I_C = -150$ mA $I_B = -15$ mA			
Base-to-Emitter Voltage V_{BE}	-1.1	-1.5 max	V
$V_{CE} = -10$ V, $I_C = -150$ mA			
DC Forward-Current Transfer Ratio			
$V_{CE} = -10$ V			
$I_C = -0.1$ h_{FE}	20	- min	
$I_C = -1$ h_{FE}	-	15 min	
I_C (Pulsed) = -150 mA ^c h_{FE}	40	50 min	
	140	250 max	
I_C (Pulsed) = -500 mA ^c h_{FE}	20	- min	
Small-Signal, Forward-Current			
Transfer Ratio h_{fe}	3	3 min	
$f = 20$ Mc/s, $V_{CE} = -10$ V, $I_C = -50$ mA			
Input Capacitance C_{ibo}	90	90 max	pF
$V_{EB} = -0.5$ V, $I_C = 0$			
Output Capacitance. C_{obo}	30	30 max	pF
$V_{CB} = -10$ V, $I_E = 0$			
Saturated Switching Time			
$V_{CE} = -30$ V, $I_C = -150$ mA, $I_B = -15$ mA t_{on}	110	- max	ns
$V_{CE} = -30$ V, $I_C = -150$ mA, $I_B = -15$ mA t_{off}	700	- max	ns
Thermal Resistance			
Junction-to-case. θ_{JC}	25	25 max	°C/W
Junction-to-free-air. θ_{JFA}	165	165 max	°C/W

^a Measured along lead at distances $\leq 1/32$ inch from seating plane.

^b CAUTION: The sustaining voltages $V_{CEO(sus)}$, $V_{CER(sus)}$, and $V_{CEV(sus)}$ MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of Test Circuit Used to Measure Sustaining Voltages.

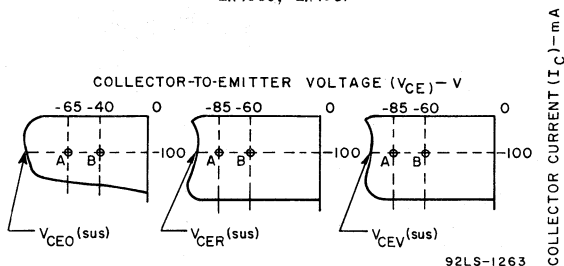
^c Pulse duration = 300 μ s, duty factor ≤ 0.02 .



2N4036, 2N4037

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGES

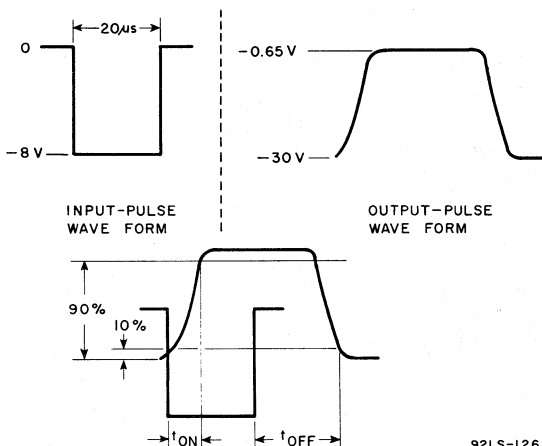
See test circuit shown for
2N4036, 2N4037



Note: The sustaining voltages $V_{CE(sus)}$, $V_{CER(sus)}$, and $V_{CEV(sus)}$ are acceptable when the traces fall to the left and below points "A" and "B" for types 2N4036 and 2N4037, respectively.

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SWITCHING TIMES

See test circuit shown for
2N4036

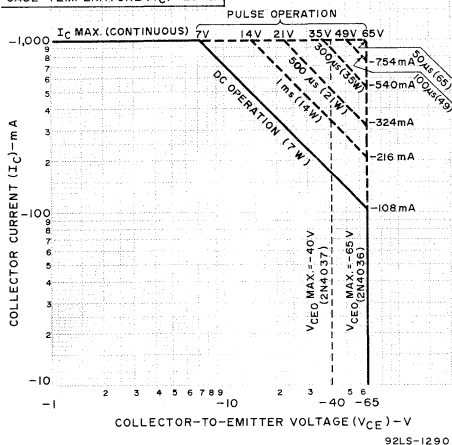


Maximum Operating Areas

Pulse Conditions

2N4036, 2N4037

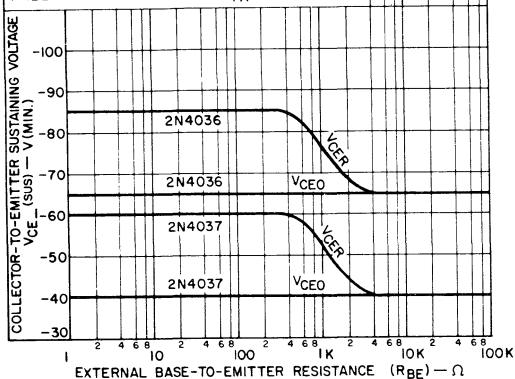
CASE TEMPERATURE (T_C) = 25°C



Sustaining Voltage vs. Base-to-Emitter Resistance

2N4036, 2N4037

COLLECTOR CURRENT (I_C) = 100 mA (PULSED)
FREE-AIR TEMPERATURE (T_{FA}) = 25°C



92LS-1256

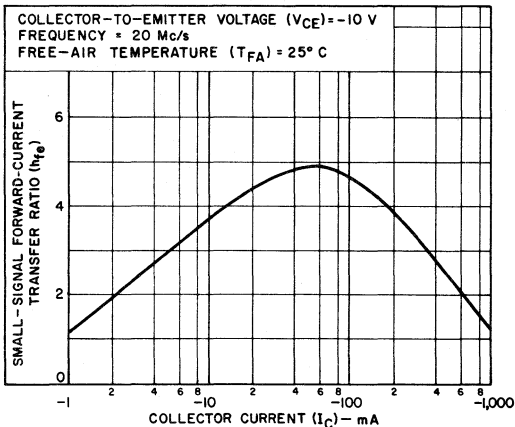


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DATA 3
4-66

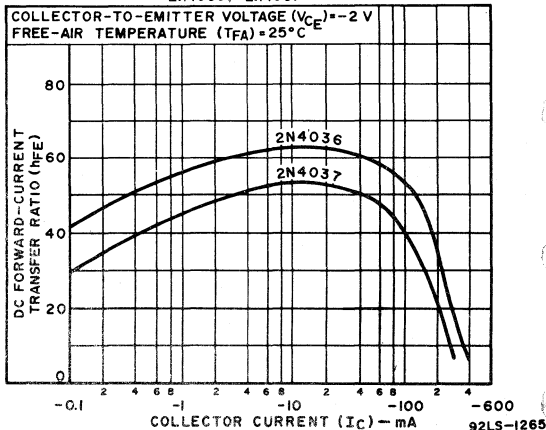
Typical Small-Signal-Beta Characteristic

2N4036, 2N4037



Typical DC-Beta Characteristics

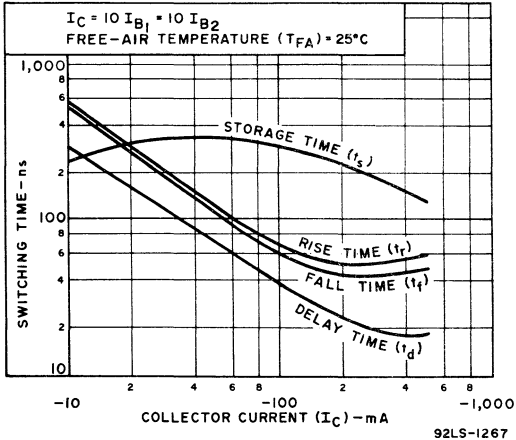
2N4036, 2N4037



2N4036, 2N4037

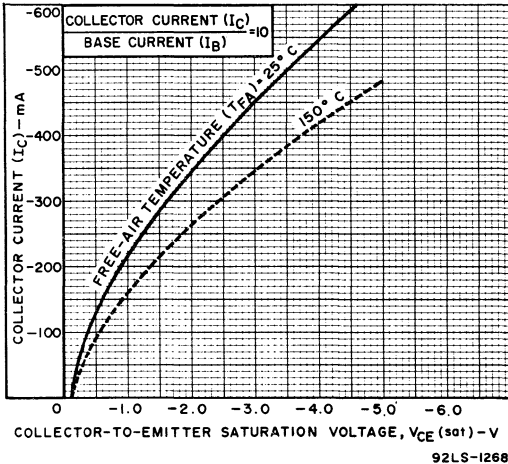
Typical Saturated Switching Times

2N4036



Typical Collector-to-Emitter Saturation-Voltage Characteristics

2N4036



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Electronic Components and Devices

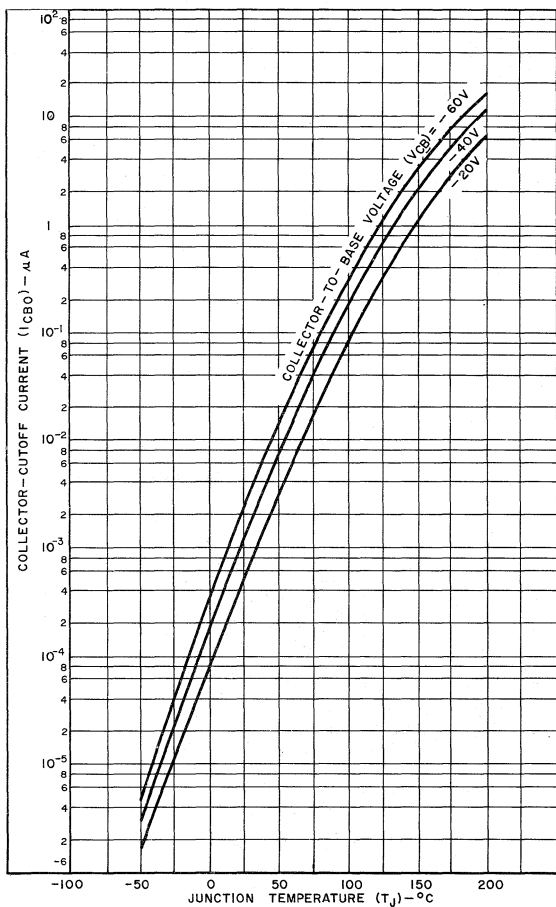
Harrison, N. J.

DATA 4
4-66

2N4036, 2N4037

Typical Collector-Cutoff Current vs. Junction Temperature

2N4036

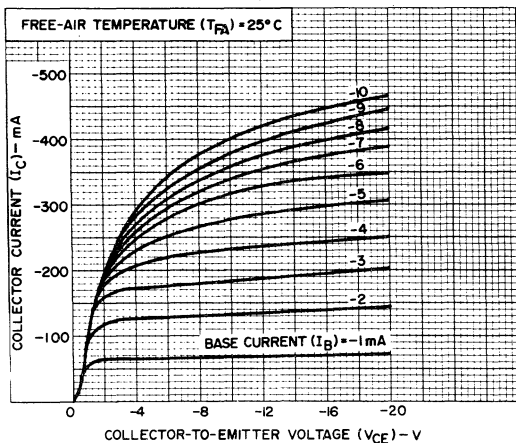


92LM-1270



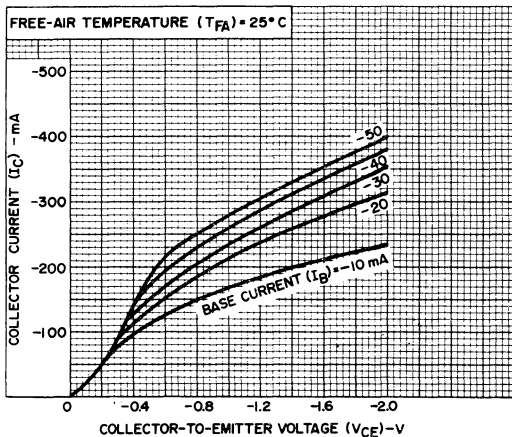
Typical Collector Characteristics

2N4037



92LS-1291

2N4037



92LS-1287



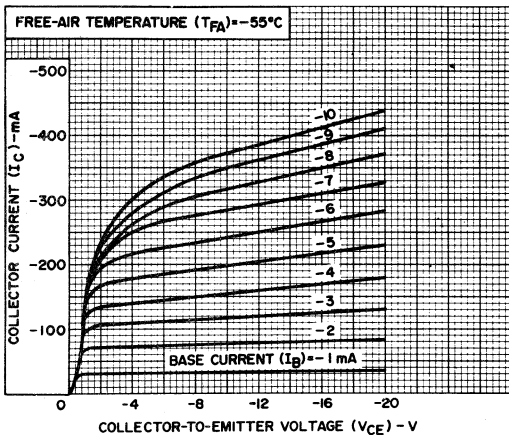
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Electronic Components and Devices

Harrison, N. J.

DATA 5
4-66

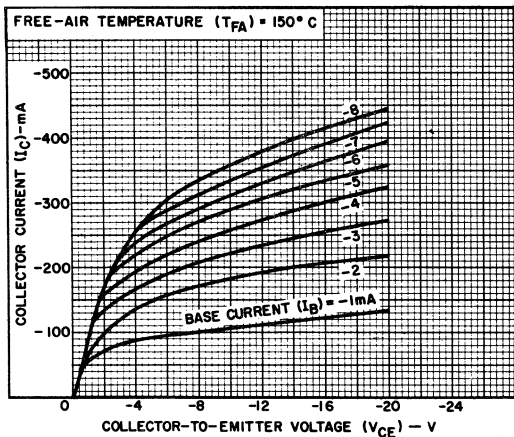
Typical Collector Characteristics

2N4037



92LS-1282

2N4037

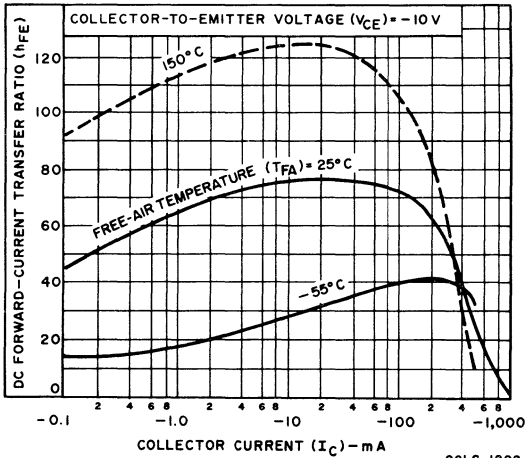


92LS-1289



Typical DC-Beta Characteristics

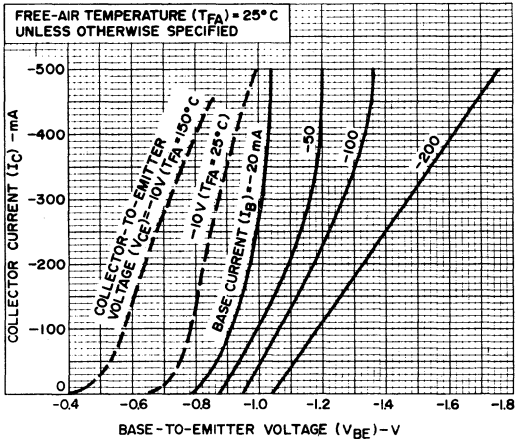
2N4037



92LS-1292

Typical Transfer Characteristics

2N4037



92LS-1295



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DATA 6
4-66

2N4068, 2N4069

Transistors

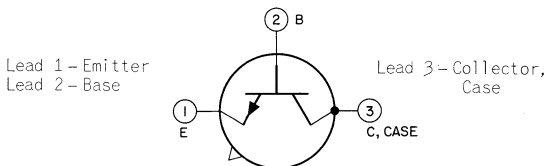
SILICON N-P-N TYPES

For High-Voltage Wide-Band and Relay-Driver Applications in Critical Industrial Equipment. The 2N4069 is the Same as the 2N4068 Except that it has an Integral Cylindrical Heat Sink of 16-Gauge Aluminum for Greater Dissipation Capability.

MECHANICAL

Dimensions See accompanying Dimensional Outlines

TERMINAL DIAGRAM (Bottom View)



ABSOLUTE-MAXIMUM RATINGS

		2N4068	2N4069	
Collector-to-Emitter Voltage	V_{CE0}	150	150	V
Emitter-to-Base Voltage.	V_{EB0}	5	5	V
Collector Current.	I_C	200	200	mA
Transistor Dissipation				
At free-air temperatures:				
From -65 to 25 °C.	P_T	0.5	1	W
Above 25 °C.	Derate linearly to 0 W at 175 °C			
Temperature Range				
Operating (Junction)	$T(opr)$	-65 to 175		°C
Storage.	$T(stg)$	-65 to 175		°C
Lead-Soldering Temperatures ^a		255	255	°C
For 10 s max				

ELECTRICAL CHARACTERISTICS

Electrode-voltage and electrode-current values for given test conditions are dc at case temperature = 25 °C

		2N4068	2N4069	
Collector-to-Emitter Breakdown				
Voltage	BV_{CE0}	{ 150 180	{ 150 min 180 typ	{ V V
$V_{CB} = 120$ V, $I_B = 0$				
Emitter-to-Base Breakdown Voltage.				
$I_E = -10$ μ A, $I_C = 0$	BV_{EB0}	{ 5 7	{ 5 min 7 typ	{ V V
Collector-to-Emitter Saturation				
Voltage		{ 1 3	{ 1 typ 3 max	{ V V
$I_B = 1$ mA, $I_C = 30$ mA				
Base-to-Emitter Saturation Voltage.	$V_{BE}(sat)$	0.68	0.68 typ	V
$I_B = 1$ mA, $I_C = 30$ mA				
Collector-Cutoff Current.				
$V_{CB} = 120$ V, $I_E = 0$	I_{CBO}	{ 5 50	{ 5 typ 50 max	{ nA nA



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Electronic Components and Devices

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DATA 1
4-66

2N4068, 2N4069

		2N4068	2N4069
DC Forward Current-Transfer Ratio	h_{FE}	$\begin{cases} 30 \\ 70 \end{cases}$	$\begin{matrix} 30 \text{ min} \\ 70 \text{ typ} \end{matrix}$
$V_{CE} = 10 \text{ V}, I_C = 30 \text{ mA}$			
Small-Signal Forward Current-Transfer Ratio	h_{fe}	80	80 typ
$f = 1 \text{ kc/s}, V_{CE} = 10 \text{ V}, I_C = 30 \text{ mA}$			
Gain-Bandwidth Product			
$f = 100 \text{ Mc/s}, V_{CE} = 10 \text{ V}, I_C = 30 \text{ mA} .$	f_T	$\begin{cases} 50 \\ 100 \end{cases}$	$\begin{matrix} 50 \text{ min} \\ 100 \text{ typ} \end{matrix}$
$f = 100 \text{ Mc/s}, V_{CE} = 140 \text{ V}, I_C = 2 \text{ mA} .$	f_T	$\begin{cases} 50 \\ 100 \end{cases}$	$\begin{matrix} 50 \text{ min} \\ 100 \text{ typ} \end{matrix}$
Thermal Resistance			
Junction-to-case.	θ_{JC}	$\begin{cases} 45 \\ 60 \end{cases}$	$\begin{matrix} 45 \text{ typ } ^\circ\text{C/W} \\ 60 \text{ max } ^\circ\text{C/W} \end{matrix}$
Junction-to-free air.	θ_{JFA}	300	150 max $^\circ\text{C/W}$

a Measured along lead at distances $\geq 1/32$ inch from seating surface.

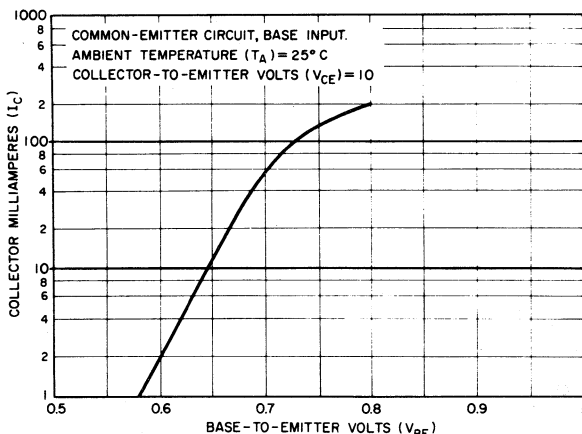
OPERATING CONSIDERATIONS

Because the metal shells of these transistors operate at the collector voltage, consideration should be given to the possibility of shock hazard if the shells are to operate at a voltage appreciably above or below ground potential. In such cases, suitable precautionary measures should be taken.

RCA-2N4068 and 2N4069 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistors.

Typical Transfer Characteristic

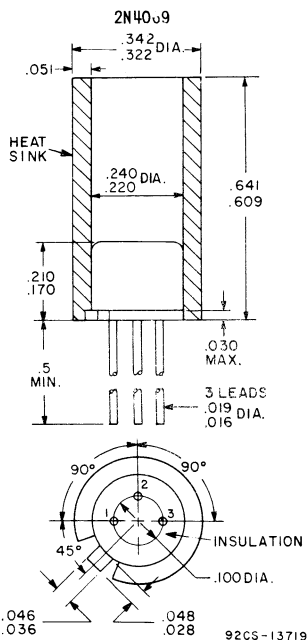
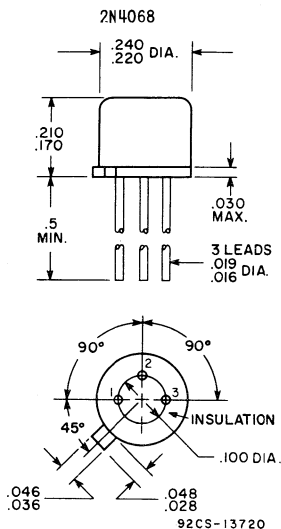
2N4068, 2N4069



92CS-13828



DIMENSIONAL OUTLINES



DIMENSIONS IN INCHES

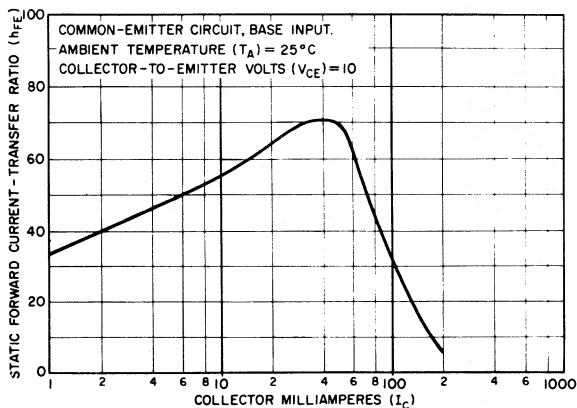


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DATA 2
 4-66

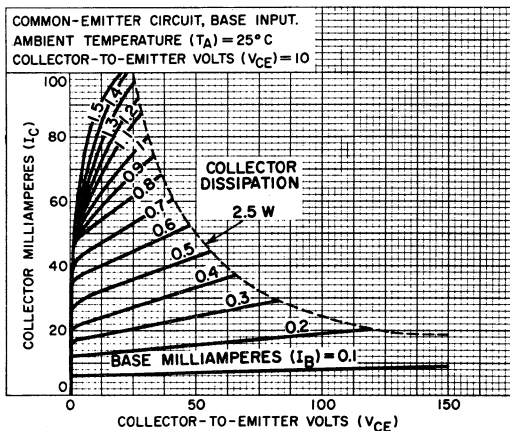
Typical Static Forward Current-Transfer Ratio (h_{FE}) Characteristic

2N4068, 2N4069



Typical Collector Characteristics

2N4068, 2N4069



Transistor

SILICON N-P-N EPITAXIAL PLANAR TYPE

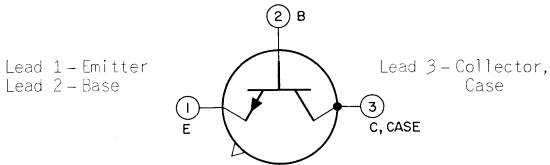
For High-Voltage, High-Current AF-Driver-Amplifier Applications in Consumer Products and Industrial Equipment.

Particular Applications are those Requiring High Peak Current and/or High Peak Voltage Capabilities, High Dissipation Capability, and Exceptional Linearity of Characteristics.

MECHANICAL

Dimensions See accompanying Dimensional Outline

TERMINAL DIAGRAM (Bottom View)



ABSOLUTE-MAXIMUM RATINGS

Collector-to-Emitter Voltage

$V_{BE} = -1$ V.	V_{CEV}	40	V
Base open.	V_{CEO}	40	V

Emitter-to-Base Voltage.

Collector Current.	V_{EB0}	8	V
Emitter Current.	I_C	300	mA
	I_E	-300	mA

Transistor Dissipation

At case temperatures:

From -65 to 75 °C.	P_T	2	W
Above 75 °C.	Derate linearly to 0 W at 175 °C		

At free-air temperatures:

From -65 to 55 °C.	P_T	400	mW
Above 55 °C.	Derate linearly to 0 W at 175 °C		

Temperature Range

Operating (Junction)	T_{opr}	-65 to 175	°C
Storage.	T_{stg}	-65 to 175	°C

Lead-Soldering Temperature^a.

For 10 s max



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DATA 1
4-66

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode voltage and electrode-current values for given test conditions are dc at case temperature = 25 °C

		Min	Typ	Max	
Collector-to-Emitter Breakdown Voltage	BV_{CEO}	40	-	-	V
$I_C = 10 \text{ mA}, I_B = 0$					
Emitter-to-Base Breakdown Voltage. . .	BV_{EBO}	8	-	-	V
$I_E = 0.05 \text{ mA}, I_C = 0$					
Base-to-Emitter Saturation Voltage . .	$V_{BE}(\text{sat})$	-	1	1.5	V
$I_B = 15 \text{ mA}, I_C = 300 \text{ mA}$					
Collector-to-Emitter Saturation Voltage.	$V_{CE}(\text{sat})$	-	0.22	0.3	V
$I_B = 15 \text{ mA}, I_C = 300 \text{ mA}$					
Collector-Cutoff Current					
$V_{BE} = -1 \text{ V}, V_{CE} = 40 \text{ V}$	I_{CEV}	-	-	10	μA
$V_{CB} = 25 \text{ V}, I_E = 0$	I_{CBO}	-	-	10	nA
$V_{CB} = 25 \text{ V}, I_E = 0, T_C = 85^\circ\text{C} . . .$	I_{CBO}	-	-	1	μA
Emitter-Cutoff Current.	I_{EBO}	-	-	10	nA
$V_{BE} = -2.5 \text{ V}, I_C = 0$					
DC Forward Current-Transfer Ratio					
$V_{CE} = 6 \text{ V}, I_C = 0.5 \text{ mA}$	h_{FE}	35	75	-	
$V_{CE} = 10 \text{ V}, I_C = 10 \text{ mA}$	h_{FE}	75	150	300	
$V_{CE} = 1 \text{ V}, I_C = 100 \text{ mA}$	h_{FE}	50	140	-	
Small-Signal Forward Current-Transfer Ratio	h_{fe}	75	175	-	
$f = 1 \text{ kc/s}, V_{CE} = 12 \text{ V}, I_C = 10 \text{ mA}$					
Small-Signal, Open-Circuit Reverse-Voltage-Transfer Ratio	h_{re}	-	125×10^{-6}	-	
$f = 1 \text{ kc/s}, V_{CE} = 12 \text{ V}, I_C = 10 \text{ mA}$					
Small-Signal Open-Circuit Output Admittance	h_{oe}	-	75	-	mmho
$f = 1 \text{ kc/s}, V_{CE} = 12 \text{ V}, I_C = 10 \text{ mA}$					
Small-Signal Short-Circuit Input Impedance	h_{ie}	-	600	-	Ω
$f = 1 \text{ kc/s}, V_{CE} = 12 \text{ V}, I_C = 10 \text{ mA}$					
Intrinsic Base-Lead Resistance. . . .	$r_{bb'}$	-	20	40	Ω
$f = 100 \text{ Mc/s}, V_{CE} = 6 \text{ V}, I_C = 1 \text{ mA}$					
Open-Circuit Common-Base Output Capacitance.	C_{ob}	-	12	20	pF
$f = 1 \text{ Mc/s}, V_{CB} = 6 \text{ V}, I_C = 0$					
Gain-Bandwidth Product.	f_T	50	80	-	Mc/s
$f = 100 \text{ Mc/s}, V_{CE} = 6 \text{ V}, I_C = 1 \text{ mA}$					
Thermal Resistance					
Junction-to-case.	θ_{JC}	-	-	50	$^\circ\text{C/W}$
Junction-to-free air.	θ_{JFA}	-	-	300	$^\circ\text{C/W}$

^a Measured along lead at distances $\geq 1/32$ inch from seating surface.

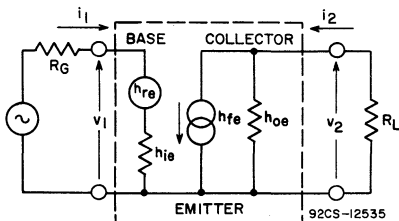


OPERATING CONSIDERATIONS

RCA-2N4074 should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the transistor.

The collector of RCA-2N4074 is internally connected to the case. Consequently, in applications where the collector of this transistor is operated at voltages above or below ground potential suitable precautions should be observed.

LOW-FREQUENCY SMALL-SIGNAL EQUIVALENT CIRCUIT CHARACTERISTICS



$$\text{Input Resistance} = \frac{v_1}{i_1} = \frac{h_{ie} + (\Delta h R_L)}{1 + (h_{oe} R_L)}$$

$$\text{Output Resistance} = \frac{v_2}{i_2} = \frac{h_{ie} + R_G}{\Delta h + (h_{oe} R_G)}$$

$$\text{Forward Current-Transfer Ratio} = \frac{i_2}{i_1} = \frac{h_{fe}}{1 + (h_{oe} R_L)}$$

$$\text{Forward Voltage-Transfer Ratio} = \frac{v_2}{v_1} = \frac{-h_{fe} R_L}{h_{ie} + (\Delta h R_L)}$$

v_1 = ac input signal voltage

i_1 = ac base current

v_2 = ac output signal voltage

i_2 = ac collector current

h_{ie} = small-signal short-circuit input impedance

h_{oe} = small-signal open-circuit output admittance

h_{re} = small-signal open-circuit reverse voltage-transfer ratio

h_{fe} = small-signal short-circuit forward current-transfer ratio

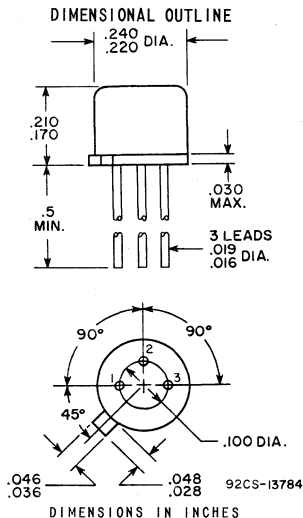
$\Delta h = (h_{ie} h_{oe}) - (h_{re} h_{fe})$

R_G = generator resistance

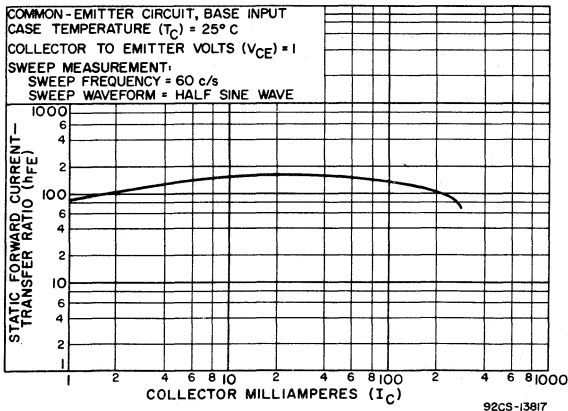
R_L = load resistance



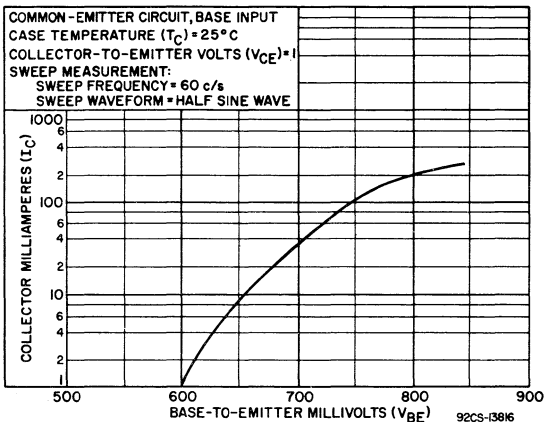
2N4074



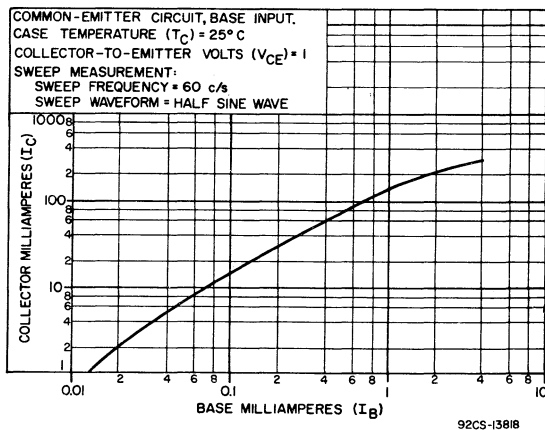
Typical h_{FE} Characteristic
2N4074



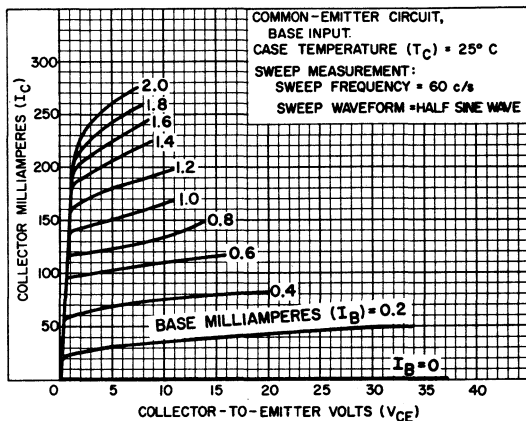
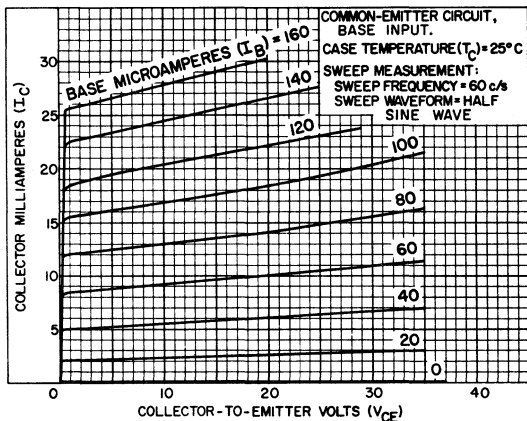
Typical Transfer Characteristic



Typical Current-Transfer Characteristic



Typical Collector Characteristics



Silicon Controlled Rectifier

(Thyristor)

ALL-DIFFUSED, 3-JUNCTION TYPE

*For Low-Cost Power-Control and Power-Switching
Applications Having High-Voltage Power Supplies*

*The 2N4101 is the same as the 2N3228 except that it is intended
for high-voltage power supplies and for the following items:*

ABSOLUTE-MAXIMUM RATINGS

*Unless otherwise specified, for sinusoidal ac supply
voltage at a frequency between 50 and 400 Hz, with
resistive or inductive load*

Peak Reverse Voltage

Gate open:

Repetitive $V_{RM}(\text{rep})$ 600 V

Non-repetitive (Transient) for
duration of 5 ms. $V_{RM}(\text{non-rep})$ 700 V

Peak Forward Blocking

Voltage (Repetitive) $V_{FBM}(\text{rep})$ 700 V

Gate open

ELECTRICAL CHARACTERISTICS

*Unless otherwise specified, at maximum electrical
ratings and at indicated case temperatures*

Forward Breakover Voltage. V_{B00} 600 min V
 $T_C = 100^\circ\text{C}$

Peak Blocking Current

$T_C = 100^\circ\text{C}$

Forward, $V_{FBO} = V_{B00}$ (min value). . . i_{FB0M} { 0.4 typ mA
4 max mA

Reverse, $V_{RBO} = V_{RM}(\text{rep value})$. . . i_{RB0M} { 0.2 typ mA
2 max mA

Thermal Resistance

Junction-to-case θ_{JC} 4 max $^\circ\text{C/W}$



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DATA
4-66

Silicon Controlled Rectifier (Thyristor)

ALL-DIFFUSED, 3-JUNCTION TYPE

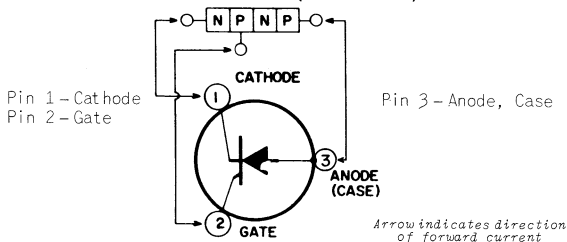
*For Low-Cost Power-Control and Power-Switching
Applications Having High-Voltage Power Supplies*

*The 2N4101 is the same as the 2N3228 except that it is intended
for high-voltage power supplies and for the following items:*

MECHANICAL

Dimensions See Outline TO-8 in General Section

TERMINAL DIAGRAM (Bottom View)



ABSOLUTE-MAXIMUM RATINGS

*Unless otherwise specified, for sinusoidal ac supply voltage at
a frequency between 50 and 400 Hz, with resistive or inductive load*

Peak Reverse Voltage

Gate open:

Repetitive $V_{RM}(rep)$ 600 V

Non-repetitive (Transient) for

duration of 5 ms. $V_{RM}(non-rep)$ 700 V

Peak Forward Blocking Voltage. $V_{FBOM}(rep)$ 700 V

Repetitive, gate open

Average Forward Current

T_{FA} without heat sink from -65 to $25^{\circ}C$:

DC value at a conduction angle of 180° I_{FAV} 1.3 A

RMS value I_{FRMS} 2 A

For other conditions. see Rating Chart (Free-air
Temperature)

ELECTRICAL CHARACTERISTICS

*Unless otherwise specified, at maximum electrical
ratings and at indicated case temperature*

	min	typ	max
Forward Breakover Voltage V_{B00}	600	-	-
$T_C = 100^{\circ}C$			V

Peak Blocking Current

$T_C = 100^{\circ}C$

Forward, $V_{FB0} = V_{B00}$ (min value) i_{FBOM} - 0.4 4 mA

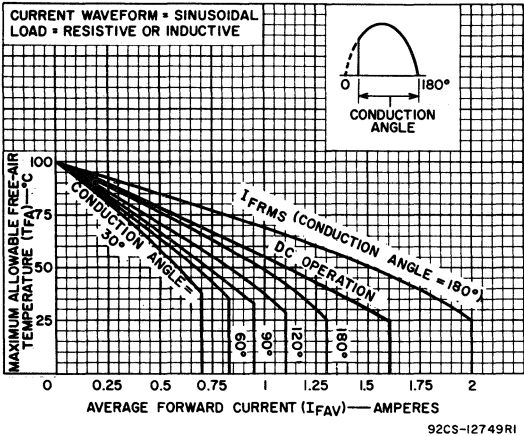
Reverse, $V_{RBO} = V_{RM}(rep)$ value) i_{RBO} - 0.2 2 mA

Thermal Resistance

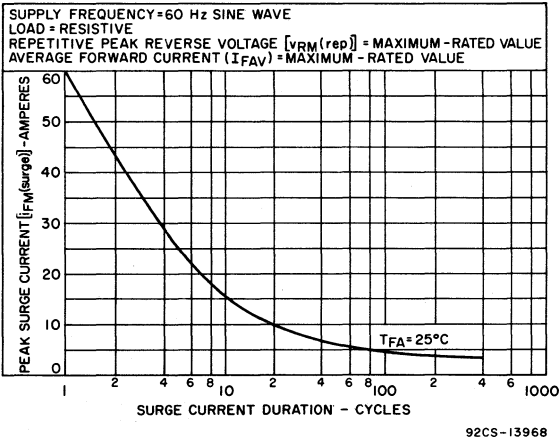
Junction-to-free air - - 40 $^{\circ}C/W$



Rating Chart (Free-Air Temperature)



Peak Surge Current Rating Chart



Silicon Controlled Rectifier

(Thyristor)

ALL-DIFFUSED 3-JUNCTION TYPE

*For Low-Cost Power-Control and Power-Switching
Applications Having High-Voltage Power Supplies*

*The 2N4103 is the same as the 2N3668 except that it is intended
for high-voltage power supplies and for the following items:*

ABSOLUTE-MAXIMUM RATINGS

*Unless otherwise specified, for sinusoidal ac supply
voltage at a frequency between 50 and 400 Hz, with
resistive or inductive load*

Peak Reverse Voltage

Gate open:

Repetitive $V_{RM}(rep)$ 600 VNon-repetitive (Transient) for
duration of 5 ms. $V_{RM}(non-rep)$ 700 V

Peak Forward Blocking

Voltage (Repetitive) $V_{FBOM}(rep)$ 700 V

Gate open

ELECTRICAL CHARACTERISTICS

*Unless otherwise specified, at maximum electrical
ratings and at indicated case temperatures*

Forward Breakover Voltage. V_{B00} 600 min V $T_C = 100^\circ C$

Peak Blocking Current

 $T_C = 100^\circ C$

Forward, $V_{FB0} = V_{B00}$ (min value) . . .	i_{FBOM}	{	0.35 typ	mA
			4 max	mA
Reverse, $V_{RB0} = V_{RM}(rep \text{ value})$. . .	i_{RBOM}	{	0.4 typ	mA
			3 max	mA



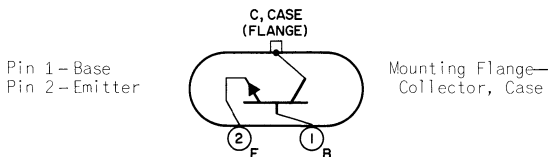
Transistor

SILICON N-P-N TRIPLE-DIFFUSED TYPE

For High-Speed Switching and Linear-Amplifier Applications such as High-Voltage Operational Amplifiers, High-Voltage Switches, Switching Regulators, Converters, Inverters, Deflection- and Hi-Fi Amplifiers in Military, Industrial, and Commercial Equipment

MECHANICAL

Dimensions. See Outline TO-66 in General Section
 TERMINAL DIAGRAM (Bottom View)



ABSOLUTE-MAXIMUM RATINGS

Collector-to-Base Voltage	V_{CB0}	500	V
Collector-to-Emitter Voltage.	$V_{CE0(sus)}$	300	V
Emitter-to-Base Voltage	V_{EB0}	6	V
Continuous Collector Current.	I_C	2	A
Peak Collector Current.	i_C	5	A
Continuous Base Current	I_B	1	A

Transistor Dissipation

At case temperatures. . . . See Dissipation Derating Curves
 and Maximum Operating Areas (DC & Pulse Conditions)

At ambient temperatures:

From -65 to 25°C.	P_T	2.5	W
Above 25°C.	Derate linearly to 0 W at 200°C		

Temperature Range

Operating (Junction).	$T(opr)$	-65 to 200	°C
Storage	$T(stg)$	-65 to 200	°C
Pin-Soldering Temperature ^a		255	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode voltage and electrode current values for given test conditions are dc at case temperature = 25° C

Base-to-Emitter Voltage	V_{BE}	1.4 max	V
$V_{CE} = 10 \text{ V}, I_C = 1 \text{ A}$			
Collector-to-Emitter Sustaining Voltage			
$I_C = 200 \text{ mA}, I_B = 0$	$V_{CE0(sus)}$	300 ^b min	V
$R_{BE} = 50 \Omega, I_C = 200 \text{ mA}$	$V_{CER(sus)}$	400 ^b min	V
Collector-to-Emitter Saturation Voltage.	$V_{CE(sat)}$	1 max	V
$I_C = 750 \text{ mA}, I_B = 75 \text{ mA}$			



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DATA 1
 6-66

Collector-Cutoff Current

$V_{CE} = 150 \text{ V}$, $I_B = 0$ I_{CEO} 5 max mA

$V_{CE} = 400 \text{ V}$, $V_{BE} = -1.5 \text{ V}$ I_{CEV} 2 max mA

$V_{CE} = 300 \text{ V}$, $V_{BE} = -1.5 \text{ V}$, $T_C = 150^\circ\text{C}$ I_{CEV} 5 max mA

Emitter-Cutoff Current I_{EBO} 0.5 max mA

$V_{EB} = 6 \text{ V}$, $I_C = 0$

Static Forward-Current Transfer Ratio

$V_{CE} = 10 \text{ V}$, $I_C = 100 \text{ mA}$ h_{FE} 40 min

$V_{CE} = 10 \text{ V}$, $I_C = 750 \text{ mA}$ h_{FE} { 30 min
150 max

Small-Signal, Forward-Current

Transfer Ratio h_{fe} 3 min

$f = 5 \text{ MHz}$, $V_{CE} = 10 \text{ V}$, $I_C = 200 \text{ mA}$

Output Capacitance C_{ob} 120 max pF

$f = 1 \text{ MHz}$, $V_{CB} = 10 \text{ V}$, $I_E = 0$

Second-Breakdown Collector Current $I_{S/b}^c$ 350 min mA

Base forward biased,^d

$V_{CE} = 100 \text{ V}$

Second-Breakdown Energy $E_{S/b}^e$ 50 min μJ

Base reversed biased,

$R_{BE} = 20 \Omega$, $L = 100 \mu\text{H}$, $V_{BE} = -4 \text{ V}$

Thermal Resistance

Junction-to-case,

$I_C = 500 \text{ mA}$ θ_{JC} 5 max $^\circ\text{C/W}$

Junction-to-air,

$I_C = 500 \text{ mA}$ θ_{JA} 70 max $^\circ\text{C/W}$

^a Measured along pin $1/16 \pm 1/32$ inch from seating plane.

^b CAUTION: The sustaining voltages $V_{CEO(sus)}$ and $V_{CER(sus)}$ MUST NOT BE measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in *Test Circuit Used to Measure Sustaining Voltages*.

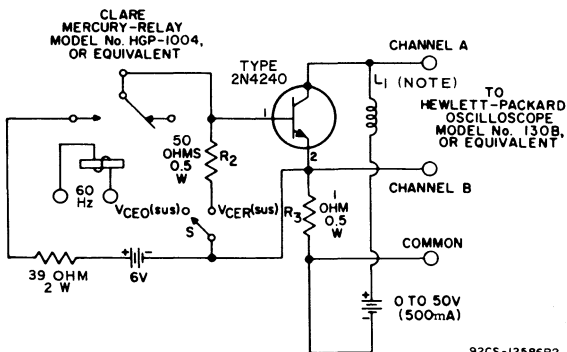
^c $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage.

^d Specified value of $I_{S/b}$ for given value of V_{CE} as base voltage is increased from zero in a positive direction.

^e $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2 LI^2$, where L is a series load or leakage inductance and I is the peak collector current.



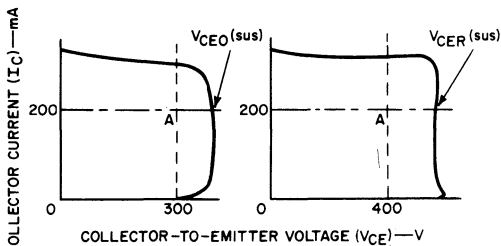
CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES $V_{CEO(sus)}$ & $V_{CER(sus)}$



92CS-12586R2

Note: $L_1 = 20$ mH for $V_{CEO(sus)}$
 $L_1 = 5$ mH for $V_{CER(sus)}$

OSCILLOSCOPE DISPLAY FOR MEASUREMENT OF SUSTAINING VOLTAGES (TEST CIRCUIT SHOWN ABOVE)



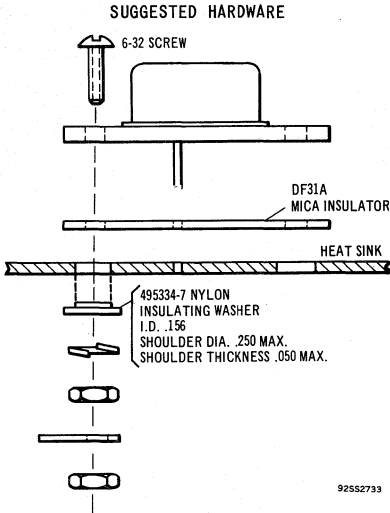
92CS-13987

Note: The sustaining voltages $V_{CEO(sus)}$ and $V_{CER(sus)}$ are acceptable when the trace falls to the right and above point "A" for type 2N4240.



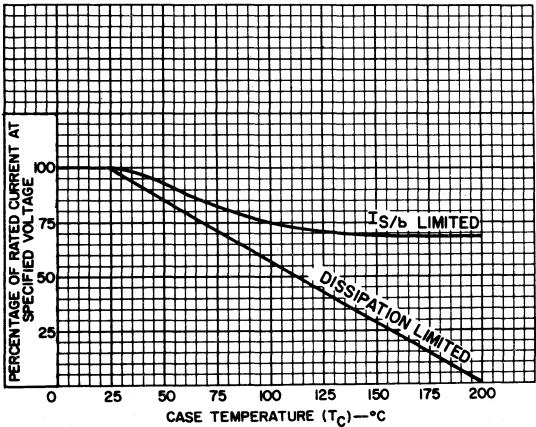
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DATA 2
 6-66



Note: Hardware with part numbers are supplied.

Dissipation Derating Curves

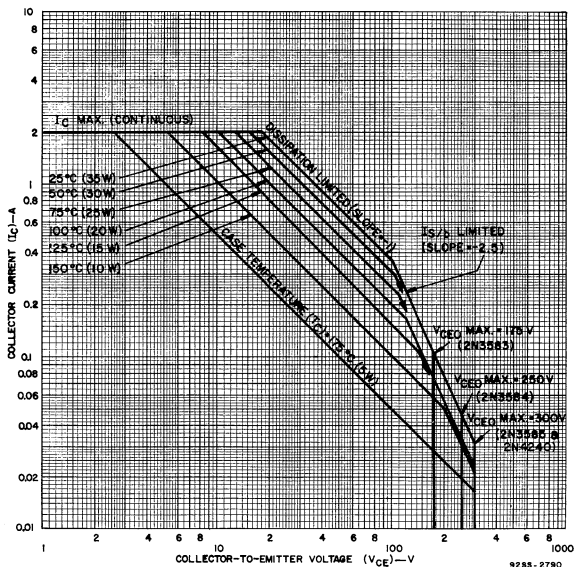


92SS-2796



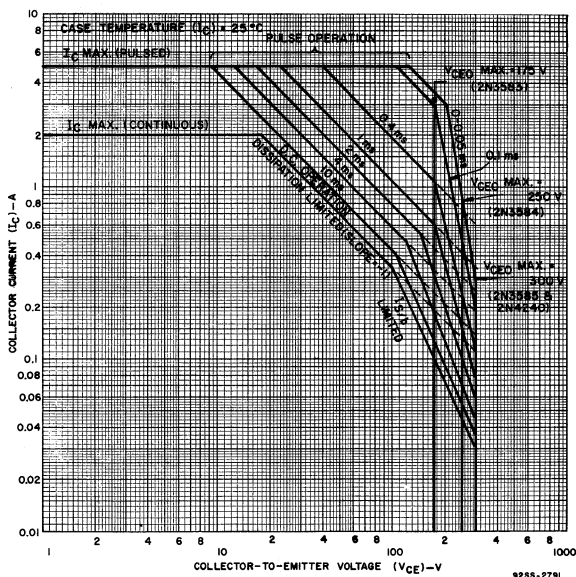
Maximum Operating Areas

DC Conditions

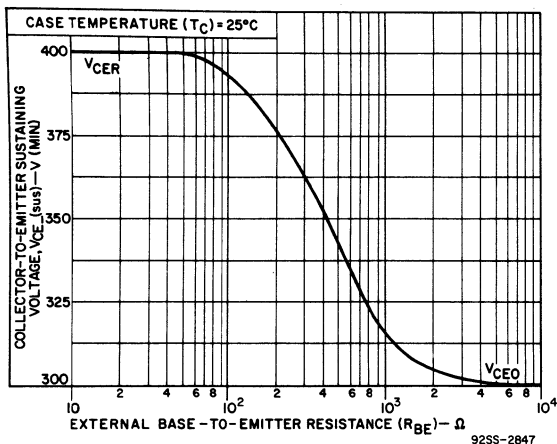


Maximum Operating Areas

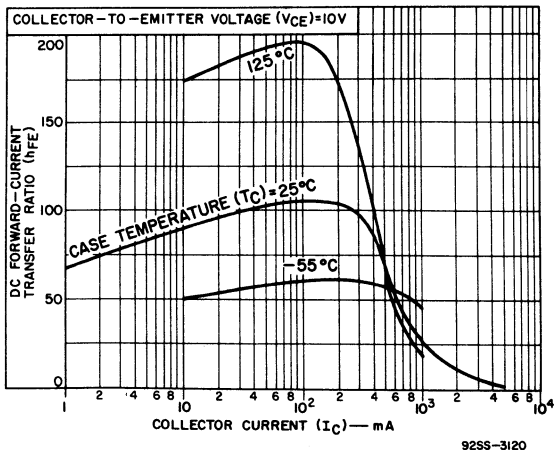
Pulse Conditions



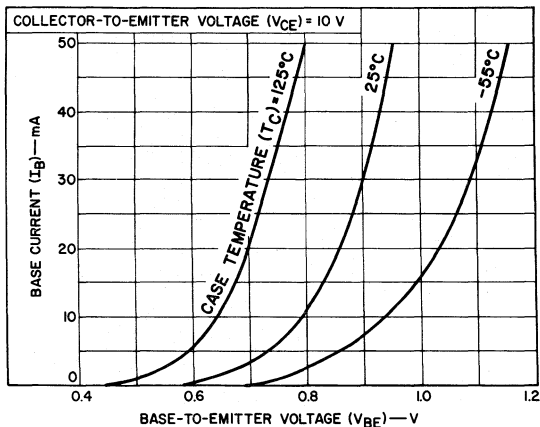
Sustaining Voltage vs. Base-to-Emitter Resistance



Typical DC Beta vs. Collector Current



Typical Input Characteristics



92SS-3131

